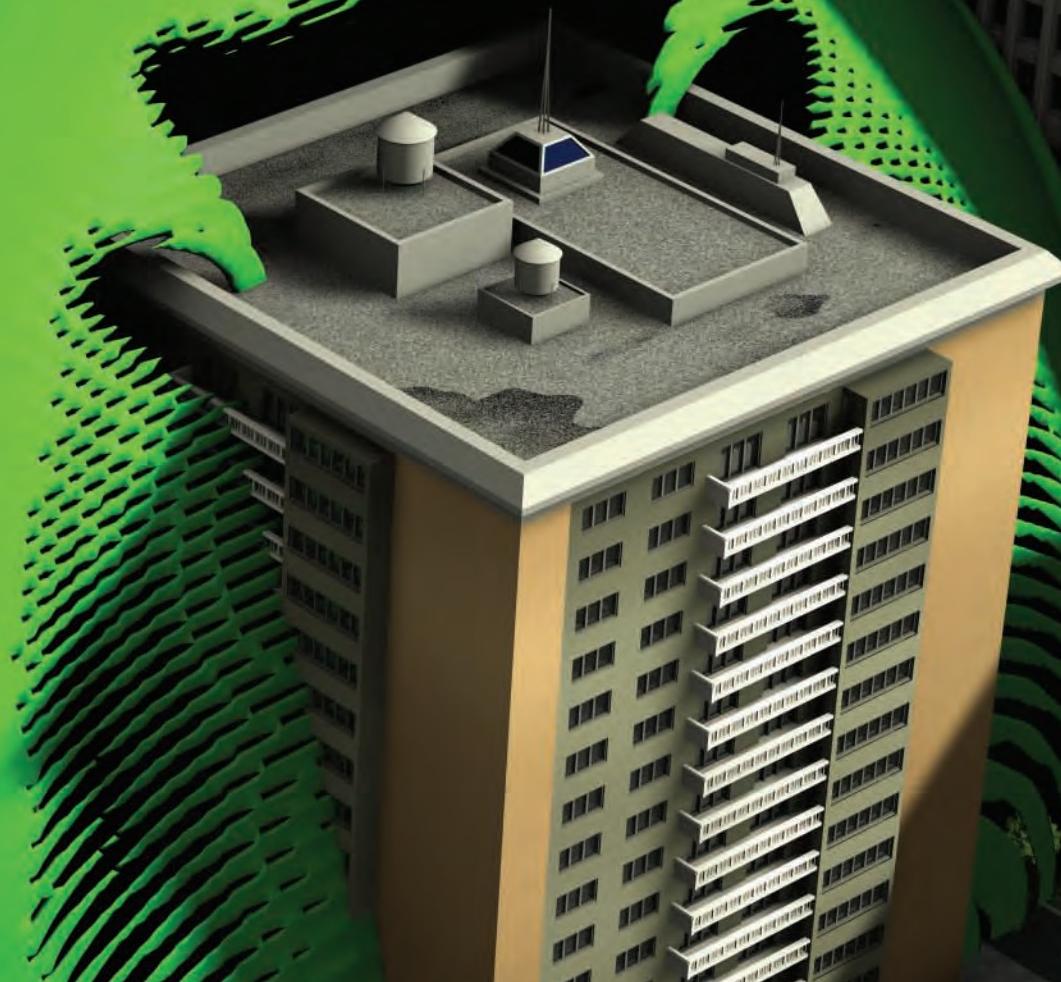


# ERDC MSRC Major Shared Resource Center RESOURCE



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1. REPORT DATE <b>2006</b>	2. REPORT TYPE	3. DATES COVERED <b>00-00-2006 to 00-00-2006</b>		
4. TITLE AND SUBTITLE <b>ERDC MSRC Resource. Fall 2006</b>		5a. CONTRACT NUMBER		
		5b. GRANT NUMBER		
		5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)		5d. PROJECT NUMBER		
		5e. TASK NUMBER		
		5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>U.S. Army Engineer Research and Development Center,ATTN: ERDC MSRC HPC Resource Center,3909 Halls Ferry Road,Vicksburg,MS,39180-6199</b>		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)		
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>				
13. SUPPLEMENTARY NOTES				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>40</b>
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>		

## from the director . . .

As you read this edition of the *Resource*, I hope that you are as impressed as I am at the never-ending stream of energy depicted herein. I see the full gamut of dedicated professional people that are represented by this publication—some represented explicitly and some implicitly. All of the individuals are necessary for the success of this program.

Be impressed by the technical accomplishments, the vision of tomorrow, the dedication to improve the user's experience, and the planning for the future.

The work being done in Airblast Technology is truly intriguing. The use of the Cray XT3 to leverage insight into High-Power Microwave technologies is awesome. Timely and inspiring is how I would describe the constant improvement to techniques and algorithms displayed in the sorting of ocean wave data and the application of user toolkits to help scientists focus on science and not on how to use the tools.

While absorbing the technological improvements, don't miss the well-deserved recognition for John West's visionary contributions to the MSRC and the high performance computing community. Take heed. Pay attention. I am sure there will be more.

The User Interface Toolkit, ezVIZ, and the update to the MSRC Web site are all examples of how we are trying to keep the support for our users fresh and up to date.

Continuing through you will notice that even though we are not upgrading one of our major systems, we continue to upgrade our MSRC infrastructure. Communications is just one area getting attention. Planning is being done to make sure that we are prepared for the continuing technological upgrades. Planning is also being done with another resource, people. Inside this edition you will see examples of how investing in our youth plays out to help secure a strong future for the MSRC.

**Greg Rottman**  
Acting Director, ERDC MSRC



Speaking of people, how much of this would be accomplished without them. Good people. Professional people. As you read these articles, think of the people that work so hard to make all of this possible. Who is the one that makes sure there is fuel in the backup generator when it is needed? Who is the one that plans for the power we need for the computer system, the air conditioners, the network devices? Who is the one that makes sure the maintenance contracts are renewed on time so that the system can be repaired? Who is the one that makes the funding available?

Just like updating algorithms and computer systems, there is a continual need for checking the infrastructure strength and potential requirements. And just like the technical and scientific work, the only way this will ever get accomplished is with dedicated individuals working as a team.

How does the saying go? It takes a village to run a supercomputer?

As always please let us know how we are doing. My e-mail address is [Greg.K.Rottman@erdc.usace.army.mil](mailto:Greg.K.Rottman@erdc.usace.army.mil).

**Greg Rottman**  
Acting Director ERDC MSRC

# Person to Watch — John E. West

By Rose J. Dykes

While serving as Director of the ERDC High Performance Computing (HPC) Major Shared Resource Center (MSRC), John West was chosen as one of the *HPCwire* “People to Watch for 2006.” According to Tom Tabor, *HPCwire* publisher, this annual list “recognizes the most influential, interesting and promising personalities having an impact on the world of High Performance Computing.” He also says, “the names on this list have been nominated by a selection committee that includes past “People to Watch” as well as a long list of advisors for the publication.” Find out more about the selections in the article entitled “*HPCwire*’s People to Watch 2006,” which can be found at <http://www.taborcommunications.com/hpcwire/features/people06/index.html>. The article states that John “is worth watching because of his visionary goals for making HPC accessible to new and diversified user groups.” *HPCwire* is considered a leading source for global information on HPC.



John E. West—dubbed by *HPCwire* in May as a person to watch for 2006



John speaks at Mississippi State University’s High Performance Computing Colloquium on August 30 (photograph courtesy of Dr. Fred Tracy)

John assumed his new role on September 2 after Dr. Jeffery P. Holland, former ERDC ITL Director, was named Acting Deputy Director of ERDC, and Dr. Deborah Dent, former ERDC ITL Deputy Director, was named Acting ERDC ITL Director.

People at Mississippi State University (MSU), John’s alma mater, have kept their eyes on John and recently asked him to speak at their HPC Colloquium at MSU. While participating in the Colloquium, he also attended the HPC Collaboratory (HPC<sup>2</sup>) Building Addition Grand Opening, at which Mississippi Governor Haley Barbour spoke. HPC<sup>2</sup> is a premier institute for advancement of computational engineering and comprises resources in computing facilities and computational expertise that are recognized internationally.

ERDC folks have also been watching John and recently named him the Acting Deputy Director of the ERDC Information Technology Laboratory (ITL), one of seven unique laboratories comprising ERDC. ERDC R&D supports the Department of Defense and other agencies in military and civilian projects and was named the Army’s Large R&D Organization of the Year in 2005.



ERDC MSRC honors John at a surprise celebration with the theme “We are Watching You”

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# ERDC's New Commander Visits ITL and ERDC MSRC

By Rose J. Dykes

Colonel Richard B. Jenkins' visit to the ERDC Information Technology Laboratory included a tour through the ERDC MSRC High Performance Computing Center and Scientific Visualization Center on September 8. He assumed command of ERDC on July 6, 2006. In thanking ITL team members afterwards, he wrote, "It was great spending time with the Lab and quite eye opening to learn more about the superb work you all are doing. I look forward to spending more time with ITL."

Prior to assuming command of ERDC, COL Jenkins was the District Engineer and Commander of the Gulf Region Division, North Districtin Mosul, Iraq, and responsible for management and quality control of billions of dollars in reconstruction and new construction throughout Iraq. His responsibilities ranged from critical infrastructure for essential utility services such as reliable electric power and clean water, to smaller yet vital projects to provide quality healthcare, transportation, and education facilities.



*Dr. Deborah Dent (left), Acting ERDC ITL Director, welcomes COL Richard B. Jenkins to ITL  
(photograph courtesy of Marsha Gay)*



*(Seated left to right) COL Jenkins, Greg Rottman, Acting ERDC MSRC Director, and Richard Walters, ERDC MSRC Scientific Visualization Center, and John West (standing), Acting ERDC ITL Deputy Director*

Before his assignment to Iraq, COL Jenkins served as Deputy Commander Mississippi Valley Division, and Secretary Mississippi River Commission. During this assignment, he deployed in 2003 as Deputy Commander and Chief of Staff for Task Force Restore Iraqi Oil.

COL Jenkins graduated from the U.S. Military Academy at West Point and has served in a variety of assignments in the United States and Europe. His military education includes the Engineer Officer Basic and Advanced Courses; Combined Arms Services Staff School; Command and General Staff College; and the Naval War College. Jenkins earned master's degrees in Civil Engineering from Cornell University and in National Security and Strategic Studies from the U.S. Naval War College. He is a registered professional engineer in the Commonwealth of Virginia.

# Computational and Experimental Studies of Airblast in Urban Terrain

By Byron J. Armstrong, Dr. James T. Baylot, and Denis D. Rickman  
ERDC Geotechnical and Structures Laboratory

Protecting United States military personnel from terrorist attacks is critical to the U.S. Department of Defense (DoD) mission success as indicated by the selection of Combating Terrorism as a Joint Warfighting Capability Objective. Real-life scenarios rarely consist of simply an explosion, the propagation of the blast load over a flat terrain, and its impact on a structure of interest. The blast environment is affected by the presence of other structures, as well as the natural topography. A complete understanding of this complex blast environment, including the effects of adjacent structures on the blast loads on a structure, is needed to protect building occupants in an urban environment. Underpredicting the loads will lead to an underassessment of the risk and to possible underdesign of retrofits to provide protection from that risk. Overpredicting the loads could lead to investing funds in the wrong location, or worse, deciding that it is not worth the investment.

The ERDC Geotechnical and Structures Laboratory (GSL) is the lead DoD laboratory for research in the civil engineering area of Survivability and Protective Structures (S&PS). The S&PS research program is focused on the warfighter's needs for force protection and counterterrorist threats. In the execution of its missions, the Army will be challenged by increasingly advanced conventional and terrorist weapons threats that will be readily available to many of the nations in the world. The threat from terrorist or saboteur weapons must be countered during peacetime as well as during military operations. The ability to determine weapons effects and predict the survivability of structures is essential for survival of the Army.

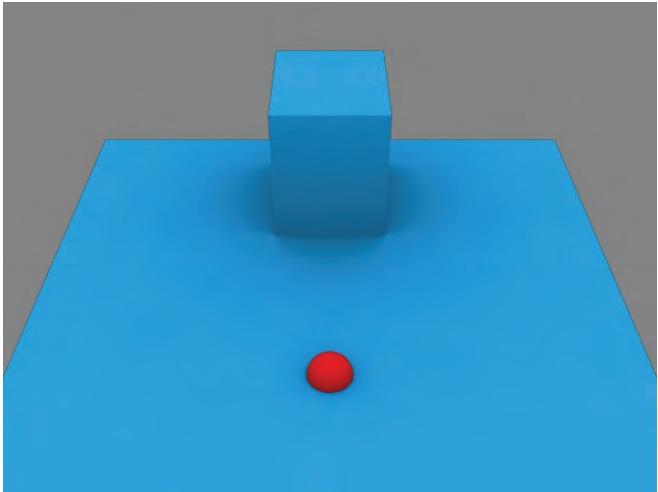
The GSL is using a combination of small-scale experiments and numerical simulations to study the blast in urban terrain. The experiments are used to collect data to study the phenomenology, as well as to validate the numerical simulations. The numerical simulations are used to assist in designing the experiments, to augment the data from the experiments, and to visualize the blast propagation in the experiments. Simulations are also used to collect "data" for experiments that either cannot or will not be conducted.

The GSL has conducted several series of small-scale experiments (Figure 1) to study the effect of adjacent buildings on blast loadings. In the first year of its blast-in-urban-terrain studies, the GSL conducted two-

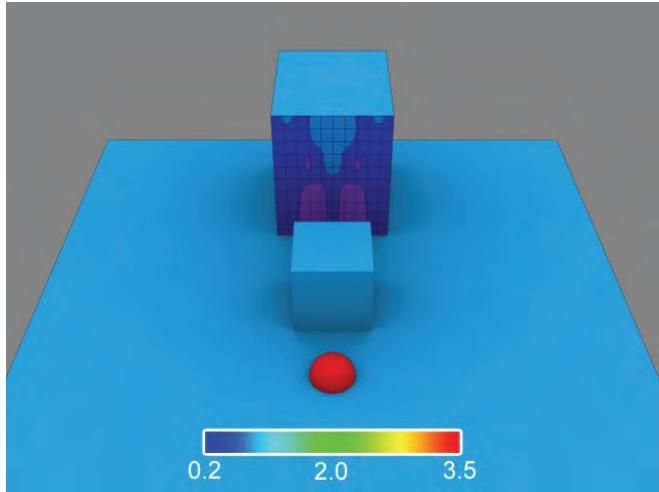
building experiments and simulations. These are aimed at studying the shielding effects of one building on the other. The explosive charge was detonated in front of one of the buildings, and pressure measurements were made on the front, back, side, and top of the building closest to the explosives and on the shielded building. Companion single-building experiments and simulations were performed for a direct comparison with the two-building experiments. The next year three-building experiments and simulations were performed, and five-building simulations were performed. Finally in the third year, nine-building portions of a typical city layout were studied.

Numerical simulations were performed to model the configurations that were tested and other configurations that were not tested. The research was conducted using an allocation of the DoD High Performance Computing Modernization Program Office (HPCMPO) Challenge processing hours at the ERDC MSRC under challenge project C83 "Evaluation and Retrofit for Blast in Urban Terrain." The Second-order Hydrodynamic Automatic Mesh Refinement Code (SHAMRC) was used for the simulations. SHAMRC is an Eulerian finite difference code refined for the explicit purpose of calculating airblast propagation. First-year simulations were performed on the IBM SMP at the Aeronautical Systems Center (ASC) MSRC. Second- and third-year simulations were performed on the Compaq SC40 and SC45 systems at the ERDC MSRC.

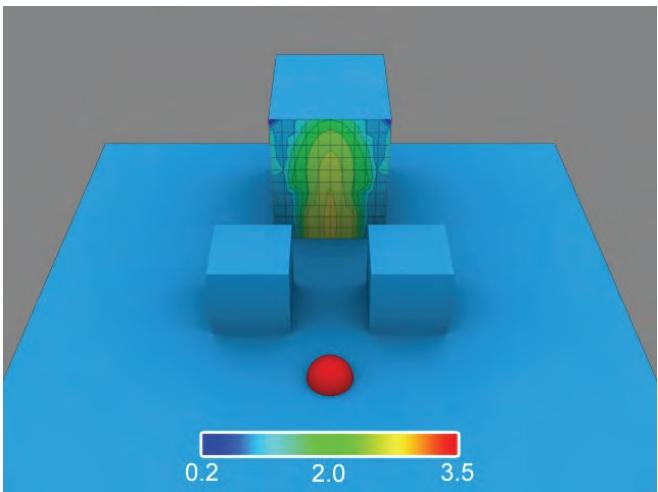
The two-building model consisted of about 38 million cells. The 25 msec simulation required 160 hours on 23 processors (3,680 processor hours) to complete the simulation. The three-building model consisted of approximately 38 million cells. The 5 msec, three-building simulation required 540 GBytes disk space and 4,100 processor hours on 32 processors. In the five-building simulation, data for animations were not saved. This significantly reduced the disk space required. The 5 msec simulation of 40 million cells was accomplished in 527 processor hours on 64 processors. A total of 12.6 square meters was modeled in this simulation. The nine-building simulations were performed in three steps. In the first step, the explosive burn was computed using a two-dimensional axisymmetric model with very fine variable cell spacing. The second model carries the shock past the nearest buildings. This model has a cell



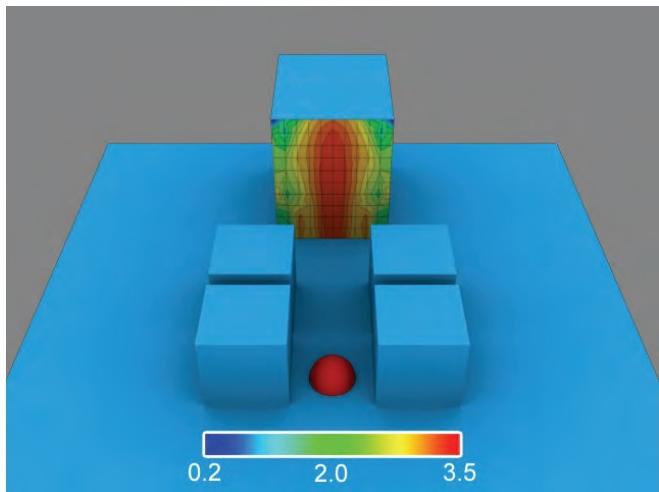
(a) Single building



(b) Two buildings



(c) Three buildings



(d) Five buildings

*Figure 1. Initial multiple building studies. Fringe plots on front of large building of ratio of peak pressure to peak pressure at same location in single-building simulation*

spacing of 0.4 cm and had about 75 million cells. Finally, the cell spacing is changed to 0.8 cm, and 89 million cells model the entire geometry. Each 20 msec simulation required 1,144 GBytes disk space and 11,000 processor hours on 64 processors.

The numerical simulations provide a more complete understanding of both shielding and focusing effects. Figure 1 compares peak pressure ratios for the two-, three-, and five-building simulations. Peak pressures were determined for a number of locations on the side of the large building closest to the explosive. At each location the peak pressure was normalized by dividing by the peak pressure for the single-building simulation (Figure 1a). Experimental data were collected at five heights on the center line of the large building.

The figure shows the expected results for the two-building simulation. Peak pressures at all locations are less than or equal to the peak pressures for the single-

building simulation. Near the top center the pressures are nearly equal to the single-building simulations. These locations are above the height of the small building that is shielding it. Near the bottom of the large building, the peak pressure is between 25 and 50 percent of the single-building value.

The three-building results illustrate both focusing and shielding effects. Near the center, the pressures are much higher than in the single-building simulation. Near the outer edges, the blast is somewhat shielded by the two smaller buildings, and the pressures are lower than in the single-building simulation. In the five-building simulation, the explosive charge is located between two of the structures, and the focusing effects on the front of the large building are severe. These focusing effects overcome the shielding effects, and the peak pressures over most of the front of the large building significantly exceed the single-building values.

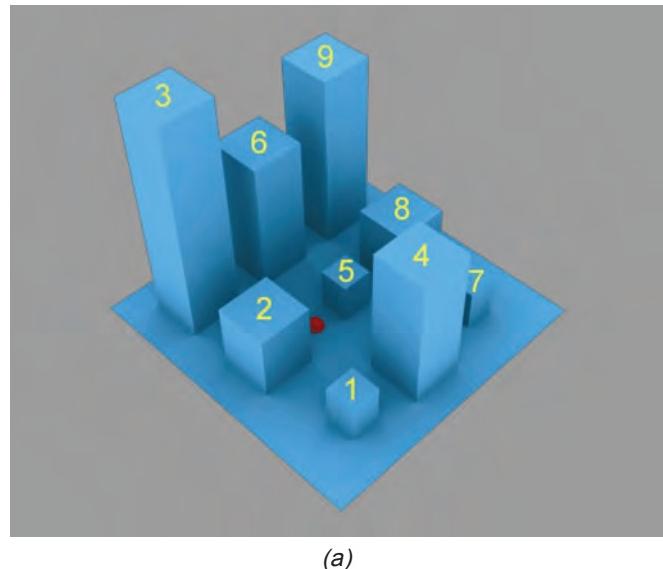
The simulations show that there are differences in shielding and confining effects when centerline values are compared with those away from the center. Since instruments were not provided at these locations, the experiments could not have illustrated these effects. The five-building simulation shows significantly enhanced confinement effects. The five-building results are based on the validated numerical model. These two results demonstrate the value of the numerical simulation in discovering effects that could not have been found using the experiments only.

One of the nine-building configurations simulated and tested in the last year of the program is shown in Figure 2. The explosive charge is detonated between buildings 2 and 5 (red dot near center of experimental photo). Figure 2 also compares the simulated pressure history with the average of the pressure histories from the three experiments tested for this configuration. The gauge was located on the back of building 5 halfway across the back and near the ground surface. Pressures and times are scaled by the same values for the simulation and the experiment. The figure shows good comparison between the experiment and the simulation. The simulation has slightly delayed arrival times, and the peak pressure for the second major pressure pulse is slightly higher in the simulation.

Pressure fringe plots at critical times affecting the loads on the back of building 5 are shown in Figure 3. Some of the complex interactions of the blast can be followed by examining these fringe plots. The initial pressure pulse shown in Figure 2 is the arrival of the direct shock propagating around building 5 at a scaled time of 0.48 and is not affected by the other buildings. The highest shock pressure peak in Figure 2 is significantly affected by the reflections off buildings 2, 4, 6, and 8. The effects of all of these reflections reach the back of building 5 at a scaled time of 1.0.

Significant improvements to SHAMRC were made during this program. Joseph Crepeau of Applied Research Associates (the current developer of SHAMRC) was very helpful in getting versions of SHAMRC executing on the MSRC systems used for this study. Paul Adams and David Longmire of the ERDC MSRC Scientific Visualization Center were very helpful in visualizing the results of the simulations. The research reported herein was conducted as part of the U.S. Army Corps of Engineers Survivability and Protective Structures Technical Area by the Weapons Effects and Structural Response Work Package, Work Units AT40-WE-001 "Development of Improved Airblast Predictive Methods" and AT40-WE-004 "HPC

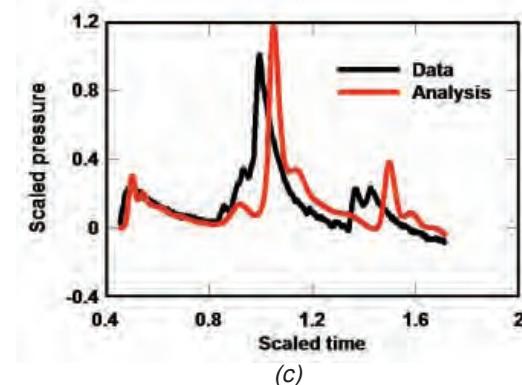
Applications for Blast Hardening." Permission from the Director, Geotechnical and Structures Laboratory, to publish this article is gratefully acknowledged. The research was conducted using an allocation of HPCMPO Challenge processing hours at the ERDC and ASC MSRCs.



(a)

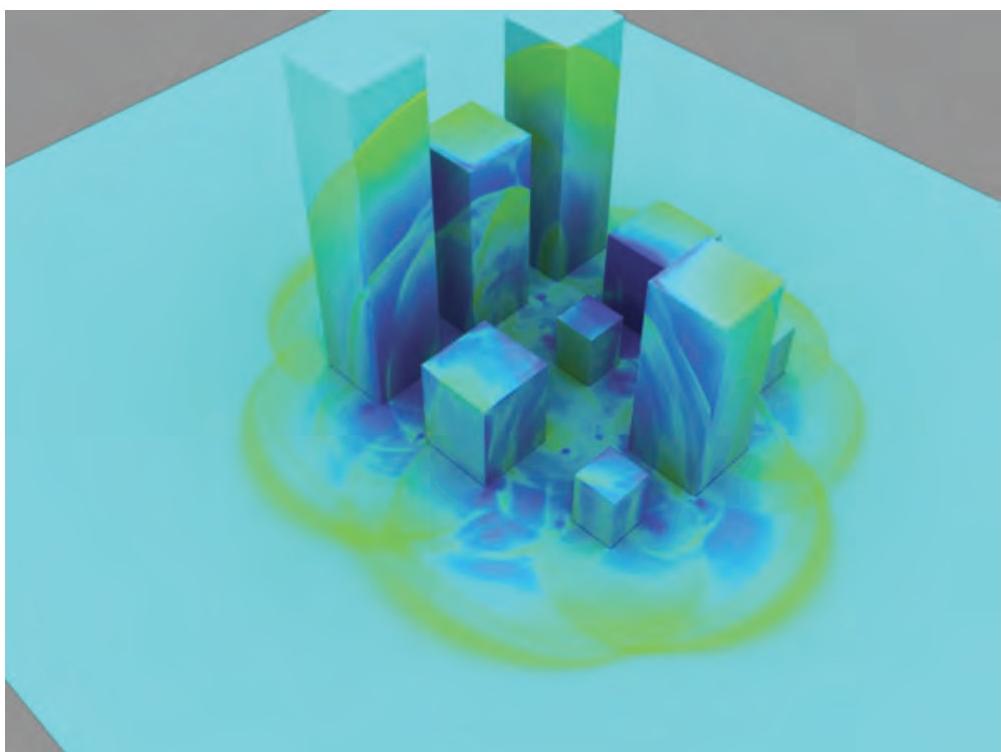
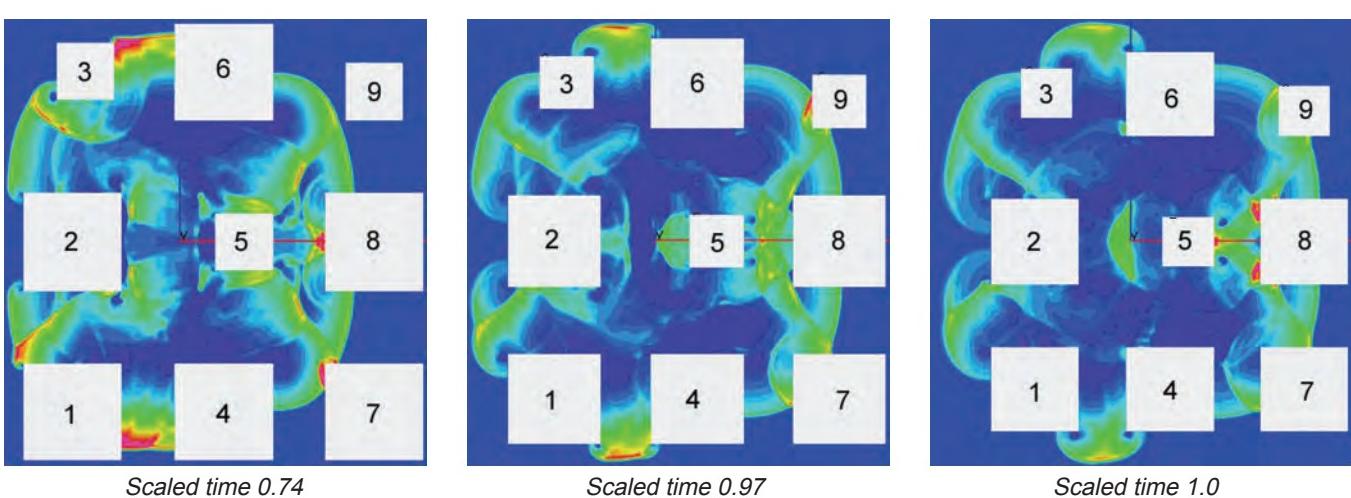
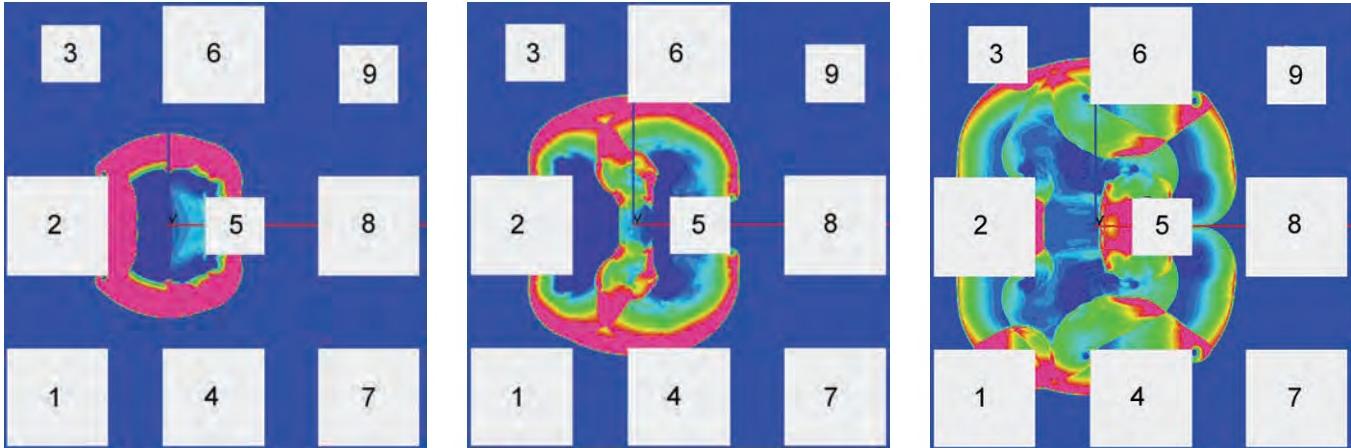


(b)



(c)

*Figure 2. Scaled pressure history comparison with average of three experiments near ground on back of building 5 for detonation between buildings 2 and 5*



*Figure 3. Pressure fringe plots on ground plane at critical times for detonation between buildings 2 and 5*

# ERDC Cray XT3 Supercomputer Aids Air Force Researchers in High-Power Microwave Technologies

By Jeff MacGillivray, U.S. Air Force Research Laboratory

Large memory capacity, fast processor speed, and the large number of processors of the Cray XT3 supercomputer, located at the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, have recently been just what the U.S. Air Force Research Laboratory scientists needed. Preliminary results have yielded good data for the study of complex temporal electromagnetic problems.

Air Force scientists involved in the project wanted to simulate new antenna designs and field interaction problems. Once validation of the antenna simulations is accomplished, modeling can then be used to assess various antenna configurations without costly construction and experiments. Field interaction modeling provides animations revealing how fields penetrate into objects.

The Air Force Research Laboratory has developed an electromagnetic finite difference time domain code TMax (Temporal Maxwell solver) for Department of Defense (DoD) application problems. TMax is a robust solver that harnesses massive parallel and vector processing to a high degree of efficiency requiring little maintenance, thereby providing a powerful electromagnetic modeling tool. By combining CAD/mesh generation tools for ultra high-resolution meshes with ever increasing DoD High Performance Computing Modernization Program (HPCMP) processor speeds and available memory, simulations of complex shapes and sizable volumes are easily realized.

The first attempt at running TMax on the ERDC Cray XT3 was completely successful. Fifteen billion cells on 1,000 processors ran in 4 hours for one incident field pass across the volume domain. Nearly every 1,000-processor run was successful. If

needed, 30 billion TMax cells will fit onto 1,000 processors or 60 billion on 2,000 processors. Over 708 million cells on only 12 processors ran on the XT3 in 10 hours, also for one incident field pass across the mesh.

The ERDC MSRC Scientific Visualization Center aided by producing animations (see image below). The animations will provide information for experiments that will indicate how much time is needed to reach steady state and field intensity on an automobile with occupants. Investigations will also be made on more complex questions.

Field interaction simulations make good physical sense and allow the experimenter to observe temporal penetration into various objects via animations. These results demonstrate that a progressively larger number of complex temporal electromagnetic problems can be solved with HPMCP computational platforms by developing software that efficiently harnesses high performance computing resources.

High-power microwaves have significant potential in command and control warfare. The low-collateral damage aspect of high-power microwave weapons makes them useful in a wide variety of missions where avoiding casualties is a major concern. A short burst of high-power microwave energy can be lethal to electronics while having no affect on humans operating the equipment.



*Image shows results of TMax simulation of high-power microwaves impacting automobile*

# Sorting Out Waves with a Fast Sort Algorithm

By Dr. Fred T. Tracy, ERDC MSRC, ITL, Vicksburg, Mississippi; Barbara A. Tracy, ERDC Coastal and Hydraulics Laboratory (CHL), Vicksburg, Mississippi; and Dr. Jeffrey L. Hanson, CHL Field Research Facility, Duck, North Carolina

## Introduction to Ocean Waves

Knowing what the ocean is going to do has been an essential part of military planning and execution since the beginning of time. Wave forecasting using numerical methods began during World War II and provided information for the Allied invasion of Normandy in 1944 (U.S. Army Corps of Engineers 2002). Knowledge about the behavior of oceans is also important for coastal design, harbors, coastal structures, and erosion control. That quickly brings the discussion to a need to understand ocean waves. Waves develop from wind blowing over the water. Waves can be very complicated as demonstrated by Figure 1 (photograph courtesy of Dr. Fred Tracy) showing part of the “Twelve Apostles” off the coast of Australia.

## Wave Information Study

The Wave Information Study (WIS) project conducted under the Coastal Field Data Collection Program in the ERDC Coastal and Hydraulics Laboratory maintains a Web-based database for ocean wave information for United States coastlines ((B. Tracy 2006a). Recently, the parallel version of WAVEWATCH III (Tolman 2002a, 2002b) was used on the ERDC MSRC Origin 3900 to model the Pacific Ocean to create a 10-year hindcast for the WIS Web site. The purpose of the hindcast is to closely match the known measured data to fill in unknown data everywhere else in the computational domain.



Figure 1. Part of the “Twelve Apostles” off the coast of Australia

## Working in Frequency Space

Figure 2 shows a time series plot of readings from the Gulf of Mexico National Data Buoy Center (NDBC) buoy 42040 during Hurricane Katrina (National Oceanic and Atmospheric Administration 2006) where the significant wave height and dominant period (reciprocal of frequency) for a given time is plotted. Important to note is that the maximum height at this particular buoy was 55 ft (16.76 m), an NDBC record. The significant wave height and dominant period are bulk parameters that describe the frequency-direction energy spectrum at this time slice and location in the ocean.

Often, a more sophisticated representation of wave data is needed that involves working in frequency space. Thus, tools like the Fast Fourier Transform are commonly used. Wave spectral partitioning methods have been developed to analyze the results (Hanson and Phillips 2001). Figure 3 (Hanson et al. 2006) shows one such representation of data from a buoy near Christmas Island in the Pacific Ocean. Here, energy

density as a function of frequency and direction is displayed. The swells are enhanced energy areas in the two-dimensional frequency-direction wave spectrum coming from distant sources other than the local wind sea region.

Another way of visualizing partitioned wave data is shown in Figure 4 (B. Tracy et al. 2006b). It consists of contours of the energy density overlaid onto a partitioning of the grid for a hindcast output station near Oahu, Hawaii, in the Pacific Ocean. The partitioning is based on a watershed algorithm (Vincent and Soille 1991) first prototyped by Hanson and Jensen (2004) for the analysis of ocean wave data. The continental divide where everything to the east goes into the Atlantic Ocean and everything to the west goes into the Pacific Ocean is a typical example of a watershed line. However, this concept of partitioning can be used in a more abstract sense as in analyzing frequency-direction data from a spatial grid.

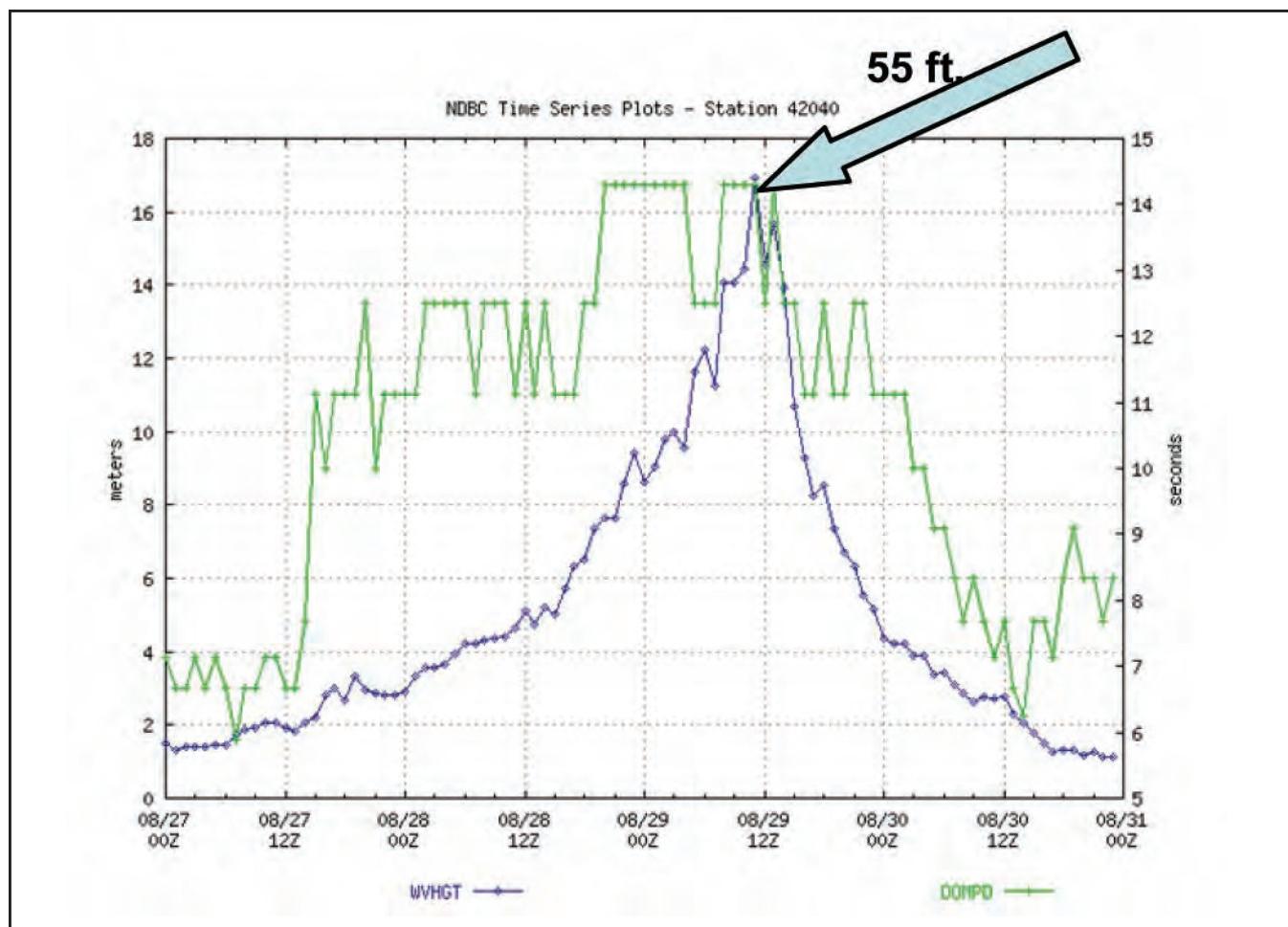


Figure 2. Time series plot of readings from NDBC buoy 42040 during Hurricane Katrina

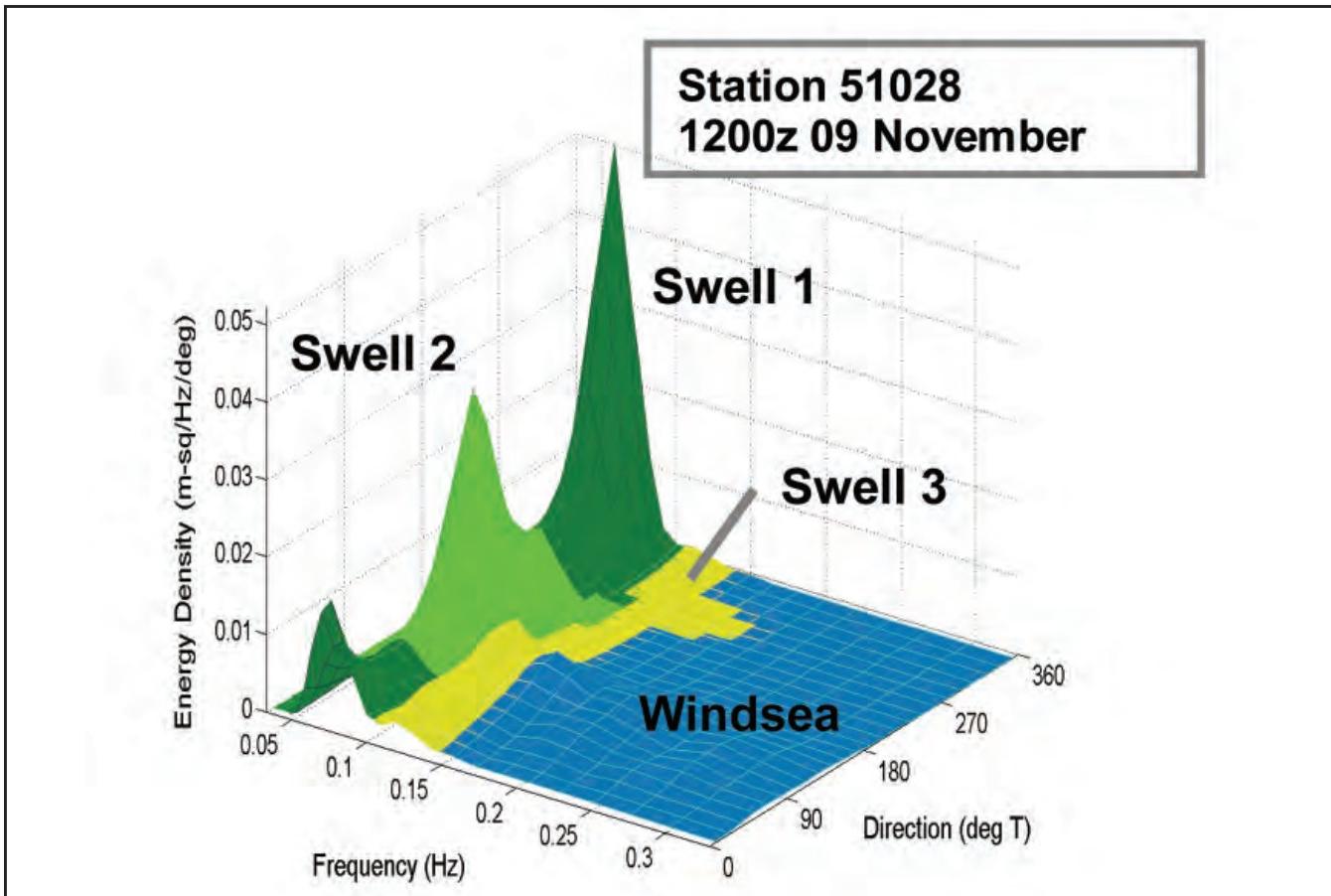


Figure 3. Energy density plot

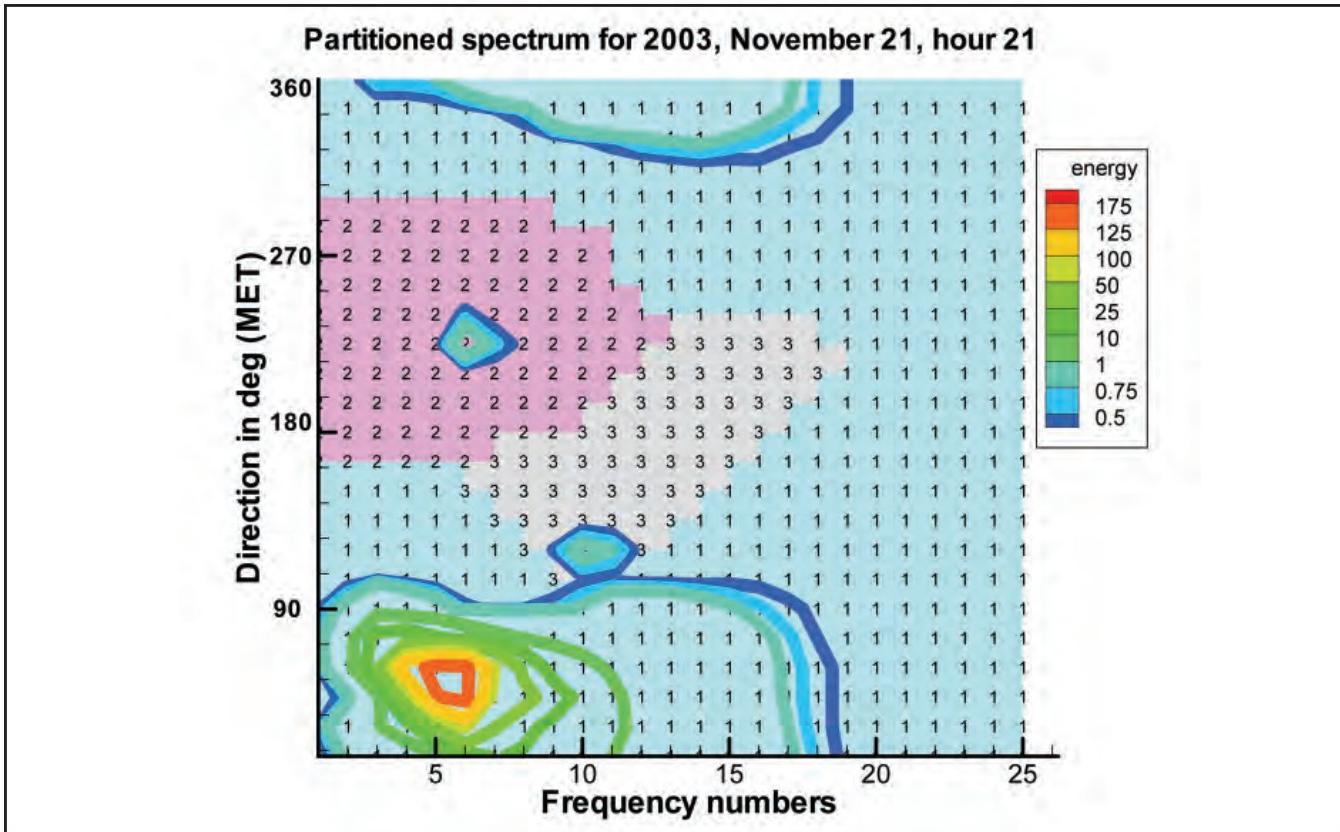


Figure 4. Contour and wave partition plot

## Watershed Algorithm

Determining the lines separating different watersheds can be done by brute force; but since any grid point in a large ocean grid ( $381 \times 257$ ) for a parallel WAVEWATCH III computation may need the computation and visualization shown in Figure 4, a quicker algorithm is needed. The improved watershed algorithm consists of four steps: (1) compute the reciprocal of each term of the energy density matrix so the valleys become ridges or watershed lines; (2) round all these new values to integers between 1 and ihmax (100 used in this work) representing a height; (3) sort the integer heights in ascending order; and (4) start at the bottom

and advance the current height one at a time, assigning partition values as climbing continues. The end result is a labeled grid with each grid point having a watershed or partition value (three in Figure 4). The grid points at the very “top of the mountain” are often given a value of one of their neighbors as was done in Figure 4.

## Fast Sort Algorithm

After the integer height image values have been placed into a single array, sorting the data in ascending order can also be very time-consuming if done by brute force ( $O(N^2)$ ). Figure 5 shows an algorithm (F. Tracy 2006) that reduces this sort to  $O(N)$ . The algorithm implements

```
c
c          Input Variables
c
c  ihmax      Largest integer height of image data.
c  imax       Number of frequencies.
c  imi        Single array containing image height data.
c  jmax       Number of directions.
c
c          Temporary Variables
c
c  iaddr     Index or address of the first value of a given integer height.
c  iv         Integer height value.
c  m, n      Do loop indices.
c  numv      Number of occurrences of a given integer value.
c
c          Output Variables
c
c  ind       Array containing indices of imi for the sorted array.
c  iorder    iorder(i) is the index of imi(i) in the sorted array.
c
c
c      parameter (imax = 24, jmax = 23, nmax = imax * jmax, ihmax = 100)
c      dimension imi(nmax), numv(ihmax), iaddr(ihmax)
c      dimension iorder(nmax), ind(ihmax)
c
c      Count the number of occurrences of each integer height.
c
c      numv = 0
c      do n = 1, nmax
c          iv = imi(n)
c          numv(iv) = numv(iv) + 1
c      end do
c
c      Compute the starting address of each integer height.
c
c      iaddr(1) = 1
c      do m = 1, ihmax - 1
c          iaddr(m + 1) = iaddr(m) + numv(m)
c      end do
c
c      Compute the new order of the points.
c
c      do n = 1, nmax
c          iv = imi(n)
c          iorder(n) = iaddr(iv)
c          iaddr(iv) = iaddr(iv) + 1
c      end do
c
c      Sort the points.
c
c      do n = 1, nmax
c          ind(iorder(n)) = n
c      end do
```

Figure 5. Fast sort algorithm

the radix sort invented by Harold H. Seward at Massachusetts Institute of Technology in 1954. The remainder of this article explains in detail the fast sort algorithm as it can potentially help any user who needs a sort routine. To illustrate the steps, consider the small example shown in Figure 6 where the heights of the reciprocals of the energy density image data have been rounded to integers between 1 and 5. The matrix has four frequency values and four directions. The four

steps for the fast sort are done with four simple loops that will now be described. Figures 6 and 7 show the intermediate values after the steps. Figure 6a shows that the data are stored in the single array row-wise, Figure 6b, the imager image data, Figure 6c, the **iorder** array, and Figure 6d, the watershed partitioning with the highest points represented by the “–” symbol. As in the continental divide example, two watersheds exist.

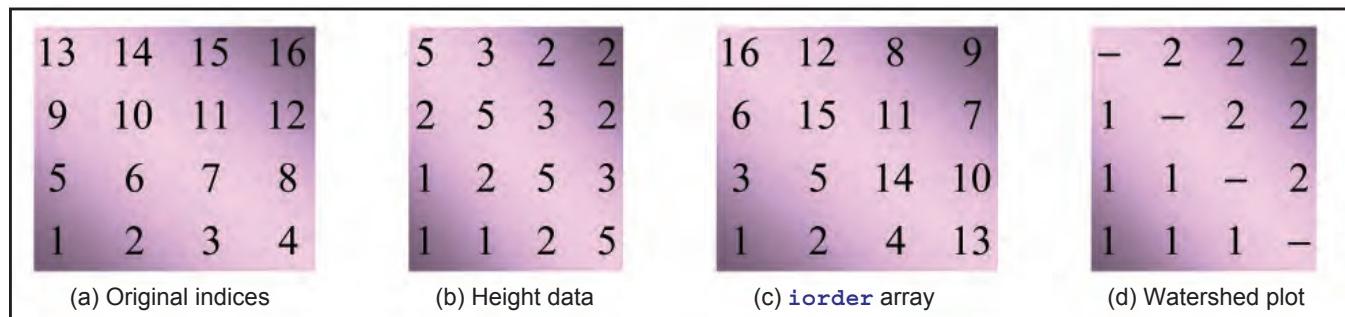


Figure 6. Small image data example

<b>Index of original array</b>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<b>Integer height values</b>	1	1	2	5	1	2	5	3	2	5	3	2	5	3	2	2
<b>iorder array</b>	1	2	4	13	3	5	14	10	6	15	11	7	16	12	8	9
<b>Indices of sorted array</b>	1	2	5	3	6	9	12	15	16	8	11	14	4	7	10	13
<b>Sorted array</b>	1	1	1	2	2	2	2	2	3	3	3	3	5	5	5	5
<b>Integer height value</b>	1	2	3	4	5											
<b>Number in each value</b>	3	6	3	0	4											
<b>iaddr array</b>	1	4	10	–	13											

Figure 7. Intermediate data for the sample problem

### Count the Number of Occurrences of Each Integer Height

```

numv = 0
do n = 1, nmax
    iv = imi(n)
    numv(iv) = numv(iv) + 1
end do

```

Here the array **numv** that contains the number of occurrences of a given value is first initialized to zero. Next, each time a particular value is encountered while going through the entire list of **nmax** (16 in the small example) points, the number of occurrences of that value is incremented by one. As shown in Figure 7, the small test problem in Figure 6 has three 1's, six 2's, three 3's, no 4's, and four 5's.

### Compute the Starting Address of Each Integer Height

```

iaddr(1) = 1
do m = 1, ihmax - 1
    iaddr(m + 1) = iaddr(m) + numv(m)
end do

```

Here, the array **iaddr** contains where each given integer height starts in the sorted array. Starting with an address of 1 for the lowest height of 1, the starting address of 2 is simply 1 plus the number of 1's; the starting address of 3 is the starting address of 2 plus the number of 2's; etc. When there are no occurrences in a given integer height, the starting address is meaningless. It does not interfere with the working of the algorithm, however.

## Compute the New Order of the Points

```
do n = 1, nmax
    iv = imi(n)
    iorder(n) = iaddr(iv)
    iaddr(iv) = iaddr(iv) + 1
end do
```

The array **iorder** is similar to telling where a given horse has placed in a horse race. For instance, the first 1 is first in the sorted array of the sample data set, and the last 5 has the last or sixteenth place. For each data point, the above loop determines the current starting address of its **iv** value in the sorted array and gives the respective data point's **iorder** value that address. The starting address of the given **iv** value is then incremented by 1 so that the next time this **iv** value is encountered, its place is one more than the previous occurrence. To illustrate, the first 1 is in first place, the second 1 is in second place, and the third 1 is in third place in the ordered array for the sample problem.

## Sort the Points

```
do n = 1, nmax
    ind(iorder(n)) = n
end do
```

Finally, the array **ind** gives a list of the indices pointing to the original **imi** array that can now be used to create the sorted array given in Figure 7. That is, **imi(ind(n))** is the  $n^{\text{th}}$  value of the sorted array.

## Future Work

The capability shown in Figure 4 and discussed above will soon be available in the latest version of WAVEWATCH III.

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# Using the User Interface Toolkit (UIT) to Run Combat Models

By Dr. Philip Amburn, James A. Moyers, and Dr. David R. Pratt, Aeronautical Systems Center Major Shared Resource Center, Wright-Patterson Air Force Base, Ohio

Forces Modeling and Simulation (FMS) is one of the 10 Computational Technology Areas (CTAs) of the User Productivity Enhancement and Technology Transfer (PET) program of the HPCMP . Dr. David Pratt is the FMS Functional Area Point of Contact and conceived and initiated the Divide and Conquer project. Jamie Moyers and Dr. Philip Amburn are the FMS team that worked on the design and implementation of Divide and Conquer and modified Divide and Conquer to use the User Interface Toolkit. The overall FMS strategic objectives are

- Leverage the HPC experience and techniques within other CTAs to improve FMS support to the operational warfighter.
- Identify new technologies appropriate for modeling and simulation of military forces in HPC environments.
- Transition the technologies to operational military programs.

Military analysts are potential FMS users of HPC resources. These analysts are primarily interested in codes that model complete things and are focused on the effects of tradeoffs and employments that affect tactical and strategic outcomes. Figure 1 displays the Modeling and Simulation pyramid of U.S Air Force (USAF) analytic models with several combat models organized into four categories. The PET program has funded work for over 2 years on a project called Divide and Conquer (DAC), which is a tool to increase the productivity of military analysts as they run combat models using HPC resources.

## Divide and Conquer

DAC was designed to help military analysts simultaneously submit multiple runs of a combat model, where each run has a different set of input parameters, often called a parameter sweep. These combat models frequently require many input files, and some models require 100 different files; but for a particular study, an analyst will routinely need to vary only a subset of all the parameters in these files. The goals of DAC are

- Reduce the wall clock time it takes to conduct an analysis
- Provide more complex analyses in shorter time
- Provide a scalable environment

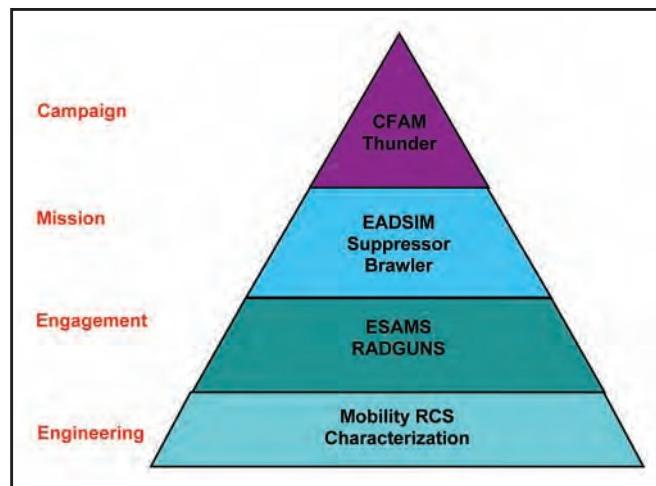


Figure 1. USAF Analytic Model Hierarchy

And the constraints are

- Don't touch my model!
- I want to work at my desk!

To meet these goals, we developed a Web-based interface that collects information for the model runs and then submits the HPC jobs for the user. Figure 2 shows one of the Web pages from DAC that analysts can use to set the parameter values for a model run. At the top of the page is a list of three input files in which these parameters will be varied. There are eight parameters to be varied; some of the parameters are floating point numbers, while others are integers; some have a list of values, while others will be varied like a "for" loop. DAC submits an individual HPC job for each combination of parameter values.

## Air Force Institute of Technology Use of Divide and Conquer

Early users of DAC are Dr. J. O. Miller and his students at the Air Force Institute of Technology (AFIT). Dr. Miller is teaching classes and conducting ongoing research in combat modeling at AFIT, and they use several of the constructive models on the AF Studies and Analysis list. He is interested in using HPC resources to support both his research and classroom activities. Dr. Miller has the following comments about DAC.

DnC: Edit Scenario - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address https://www.svdr.org/dac/edit\_scenario.php?sim=suppressor&scen=bomb\_phil&source=user

## Edit Scenario

Editing "bomb\_phil" scenario for suppressor simulation.

input/mod/bomb\_demo.dat [Edit](#)  
 input/sdb/bomb\_demo.dat [Edit](#)  
 input/tdb/bomb\_demo.dat [Edit](#)

Symbol	Type	Value Specifier	Value	Action
BMBR-APPROACHING-ROUNDS	INTEGER	LIST	4	<a href="#">Delete</a>
BOMBER-HIGH-ALT	FLOAT	LIST	2200.0	<a href="#">Delete</a>
BOMBER-LOW-ALT	FLOAT	LIST	1200.0,1300.0	<a href="#">Delete</a>
BOMBER-SCENARIO-SPEED	INTEGER	LIST	235	<a href="#">Delete</a>
RANDOM SEED	INTEGER	LOOP	10000,100000,200000	<a href="#">Delete</a>
SAM-MSL-CLOSE-PK	FLOAT	LIST	0.75	<a href="#">Delete</a>
SAM-SALVO-SIZE	INTEGER	LIST	2	<a href="#">Delete</a>
TOTAL-SAM-ENGS	INTEGER	LIST	1	<a href="#">Delete</a>

Add Symbol

[Back to list of your scenarios](#)

Figure 2. Divide and Conquer Web page for modifying parameters

"What makes DAC good for us is it allows our students, primarily analysts and not hard core computer types, to be able to harness the power of a 'supercomputer' with a combat model without having to worry about UNIX or even the specific procedures required to get one of these difficult to execute, data intensive, combat models to run. Not only can they execute these models with this nice web-based interface, but they can also set up a sophisticated experimental design (given that we have identified the factors we want to change and how we want to vary the levels) to easily explore a potentially large solution space. We have used DAC in both my Joint Combat Modeling I and II classes (first focuses on high resolution models – engagement and mission level, while the second is also referred to as Aggregated Combat Modeling, putting us at the campaign level)."

### Incorporating UIT within DAC

The DAC system is written in Python and uses TurboGears for database and Web hosting. The UIT provides the capabilities needed to connect to HPC resources from outside the HPCMP environment. DAC runs on a Web server and needs to authenticate users, copy files to and from HPC machines, etc. The UIT API provides easy access to HPC resources, and it has been approved by the HPCMP security office—two significant benefits. To make this as easy to use with DAC as possible, we wrapped UIT API calls with two Python classes, UITConnectionFactory and UITConnection. UITConnectionFactory supports Kerberos authentication and establishes a connection to an HPC host. UITConnection wraps a subset of the UIT API for file transfer, file and directory management, etc. By wrapping the UIT API calls within these Python classes, we insulated the DAC code from the Python SOAP interface requirements and details of the

UIT API. For example, the following four lines of code authenticate a user and copy a file from the local host (a Web server for DAC) to the HPC machine. The second line authenticates a user; the third line establishes a connection to hpc11.asc.hpc.mil; and the fourth line copies a file from the HPC to the local host.

```
uitcf = UITConnectionFactory()
uitcf.authenticate(username, password, secureid_code, "ASC.HPC.MIL")
hpc11 = uitcf.getConnection("hpc11")
hpc11.copyFileFromHPC("/hafs11/moyersj/foo.dat", "/tmp/foo.dat")
```

The Python code that wraps the authenticate method in the UITConnectionFactory class is below and shows how this encapsulation insulates the calling program from details of the UITAPI.

```
#-----
#      authenticate: get Kerberos credentials
#
def authenticate( self, name, password, passcode, realm ):
    credentials = """
        <credentials>
            <username>%s@%s</username>
            <password>%s</password>
            <passcode>%s</passcode>
        </credentials>"""\ % (name, realm, password, passcode)

    self.userName = name

    try:
        self.authtoken = self.server.authenticateUser(credentials,
'MSRC_KERBEROS')
    except:
        status = False
        print "\n--> failed to get kerberos credentials\n"
    else:
        status = True
        #print "\n--> got credentials\n"

    return status
```

## Summary

Divide and Conquer (DAC) now requires the UIT, and wrapping a subset of the UIT API in two Python classes made the switch to using the UIT for HPC interaction “easy.” The effort to learn the UIT and build and test the Python classes required only 4 weeks of our time. While it is still early in this effort, the approach has proven quite useful and effective. DAC provides a capability that FMS presents to various military analysis organizations, and it is critical to offer them this capability for *easy* use of HPC resources to run standard, approved combat models.

# What is ezVIZ?

By Randall Hand

In 2000, the top computer in the world, IBM's ASCI White, had a maximal achieved performance of 2.38 TFLOPS. In 2004, 77 computers were more powerful than ASCI White, which is now 30 times slower than the fastest computer. This trend is expected to continue, with the first PFLOPS machine being available in 2007. With the ubiquitous availability of TFLOPS machines, the associated data are growing at an increasing rate. Terabyte data sets are now common.

Gaining useful information from the data is a challenging task. This task often falls to the researcher or a visualization scientist. Extracting insight from a multiterabyte data set presents the researcher with several problems. These problems include transfer and storage of the data, graphics hardware to visualize it, as well as having visualization software capable of handling the data.

ezVIZ tackles the visualization problems of the researcher by providing one of two mechanisms. The first is a batch visualization capability. This batch capability allows the users to create images from their data while the data still reside on the supercomputer. These images, which are less than a few megabytes in size, can then be moved with ease to the researcher's workstation. Storage and network bandwidth are no longer a concern when visualizing the data. The second mechanism is to provide a Web interface to visualizing the data. This mechanism is currently under development.

## Current State of ezVIZ

ezVIZ is now officially released and available on all HPC systems at ERDC. Currently at version 1.1, it has improved significantly from the early beta tests and boasts a wide feature set including support for over 30 input formats and 7 rendering operations.

The screenshot shows the ezVIZ v1.1 web interface. At the top, there is a navigation bar with links for Home, HowTos, ExampleScripts, and Documentation. To the right of the navigation bar is the ERDC MSRC logo and a search bar. Below the navigation bar, the title "ezVIZ Script Generator" is displayed above a "Home" section. The "Home" section contains a welcome message about the ezVIZ Script Generator, a list of 5 main steps for creating a script file, and a note about starting the generator. On the left side, there is a vertical sidebar with icons for Home, Input, Render, Output, Colormap, and Misc. At the bottom of the page, there is a "Next >>" button. The right side of the interface shows a timeline of recent activity, listing various tasks and dates such as 31 July 2006, 25 July 2006, and 12 July 2006.

ezVIZ Web site

In addition to the previous rendering operations, there are now a few new rendering modes:

1. Model/Surface - Render polygonal geometry, or extract outer volume surfaces
  2. Flow Glyphs - Place objects in a flow field, oriented and scaled by the flow
  3. Streamlines - Generate lines to represent the flow
  4. Volume Rendering - Full ray-cast visualizations of 3-D volumes
  5. Isosurface/Contour - Extract a polygonal surface or contour line from a volume
  6. NEW! Cross Section - Extract a planar cross section from a data set
  7. NEW! Molecule - Generate ball-stick renderings from molecular data

PNG, BMP, JPG, TIF, PNM	BYU	DEM
VTK XML & Legacy	MetalImage	Wavefront OBJ
Stanford PLY	STL	Unigraphics Facet
Protein Data Bank	XYZ XMol Files	ASCII Facet
Gaussian Cube	CFDViz's Poly Format	POP Ocean files
AVS UCD	Plot3D	Xdmf/Xmdf
IRC Info Packet	ExodusII	CTH (SpyPlot)
Ensight	Quoddy	ADCIRC

## *Input File Formats*

**ezViz v1.1** A Cross-Platform Open-Source Visualization System

**ERDC** Major Shared Resource Center

Home    HowTos    ExampleScripts    Documentation

close   close others   view   permalink   references   jump

**ezVIZ Script Generator**

search

close all   permaview   options »

Timeline All Tags More

31 July 2006   VolumeOfInterest  
InputOperations  
25 July 2006   HowToRenderAMolecule  
HowTos  
ChangeLogV1dot1  
IrcInfoPacket  
SiteTitle  
VisualizationMethods  
ExampleMoleculeRendering1  
ExampleScripts  
InputFormats  
ChangeLogV1dot2  
ChangeLogs  
12 July 2006   HowToExtractAClipVolume  
11 July 2006   SelectingAComponent  
HowToExtractAnIsosurface  
ADCIRC  
BoundingBoxes  
BackgroundColors  
CameraPositioning  
ChangeLogV0dot6  
DataThresholding  
ChangeLogV1dot0  
DataTransformation  
ExampleCrossSection1  
ExampleFlowGlyphs1  
ExampleIsoSurface1  
ExampleModel1  
ExampleModel2  
ExampleVolumeRendering1  
EzVizDebugLevels

## Input

Input Format: Automatic Selected based on file extension

Input Options

File:

Regioning  
With this feature you can extract only a subvolume of your dataset for processing. As this operates on IJK coordinates, it is only available with structured data. Unstructured data will simply ignore this (with a warning).

Enable Regioning

I	J	K
Lower Bound:	<input type="text"/>	<input type="text"/>
Upper Bound:	<input type="text"/>	<input type="text"/>

Thresholding  
With this feature you can extract only a subvolume of your dataset for processing. By specifying a field and a range of values, only cells and points within that range will be processed.

Enable Thresholding

Scalar Field:	<input type="text"/>
Minimum Value:	<input type="text"/>
Maximum Value:	<input type="text"/>

Note: This will convert your data into an unstructured dataset, and can introduce holes into a dataset that will interfere with certain connectivity operations (like Streamlines).

Formula Calculation  
With this feature you can specify arbitrary per-point formula to be calculated on the data prior to rendering. Simply use the form "result=formula" and separate multiple formulae by semicolons. The result of all formulae will be double-precision floating point, and the number of components will be automatically detected by the functions used.

*ezVIZ Script Generator Web site*

Documentation for all of these features can be found on the new ezVIZ Web site. Simply point your browser to <https://solutionhpc.erdc.hpc.mil/EZHPCWebClient/ezVIZ/ezViz.html>, or click on the ezVIZ link from ezHPC. On the ezVIZ Web site, you can find full documentation of both ezVizGeneric and the ezVIZ C++ API, along with examples and “how to’s” for all major features.

### What's in store?

There's still much active development going on for ezVIZ. In the near future, you can expect to see a Web-based ezVIZ Script Generator to help you build the ezVizGeneric scripts and submit the jobs. That Web site will offer a fully interactive and dynamic interface for building scripts that will result in a fully usable script to submit to the HPCs, or even a simple “Submit” button to submit the render job via ezHPC.

Also, the next version (v1.2) of ezVIZ is already under development. Expected features include the following :

- Support for Hierarchical and AMR data sets
- Better use of Parallel Resources - For better use on clusters and the XT3
- Plugin support for Input Formats - If ezVIZ doesn't read your data natively, write your own reader
- Combination Visualization - Combine the results of multiple ezVIZ scenes into a single image
- More input formats
- Much more...

ezVIZ already boasts over 52,000 executions and 5,000 CPU hours in the first 6 months of logging. With that data we've learned a lot about how visualization is used on the systems and what kind of functionality is missing. We've taken huge steps to filling in these gaps, and as a result have seen significant improvements in stability features, and ease of use. Only through continued usage and development can ezVIZ continue to be useful and provide the constantly changing capabilities that have proven useful.

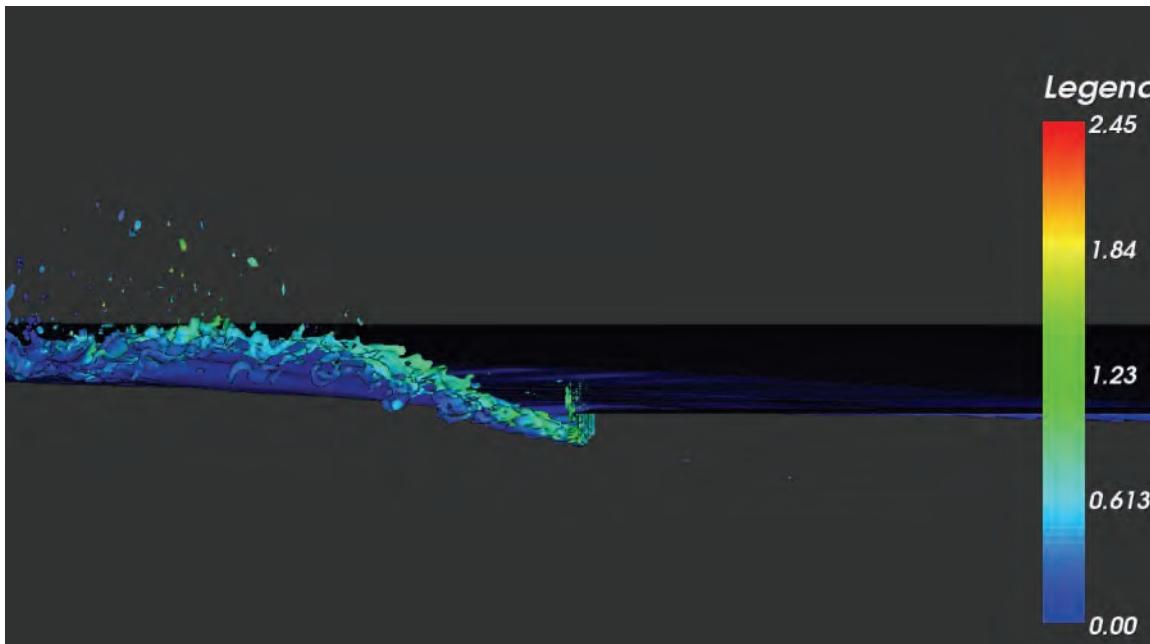
```
[input]
format=VTK

[output]
format=PNG
size=HDTV
file=frame.png

[render]
operation=isosurface
scalarfield=fraction
isovalue=0.5
elevation=-88
zoom=12.0

[colormap]
stretch=on
colorfield=Velocity
colorcomponent=magnitude
```

Example ezVizGeneric Script



Example ezVIZ output

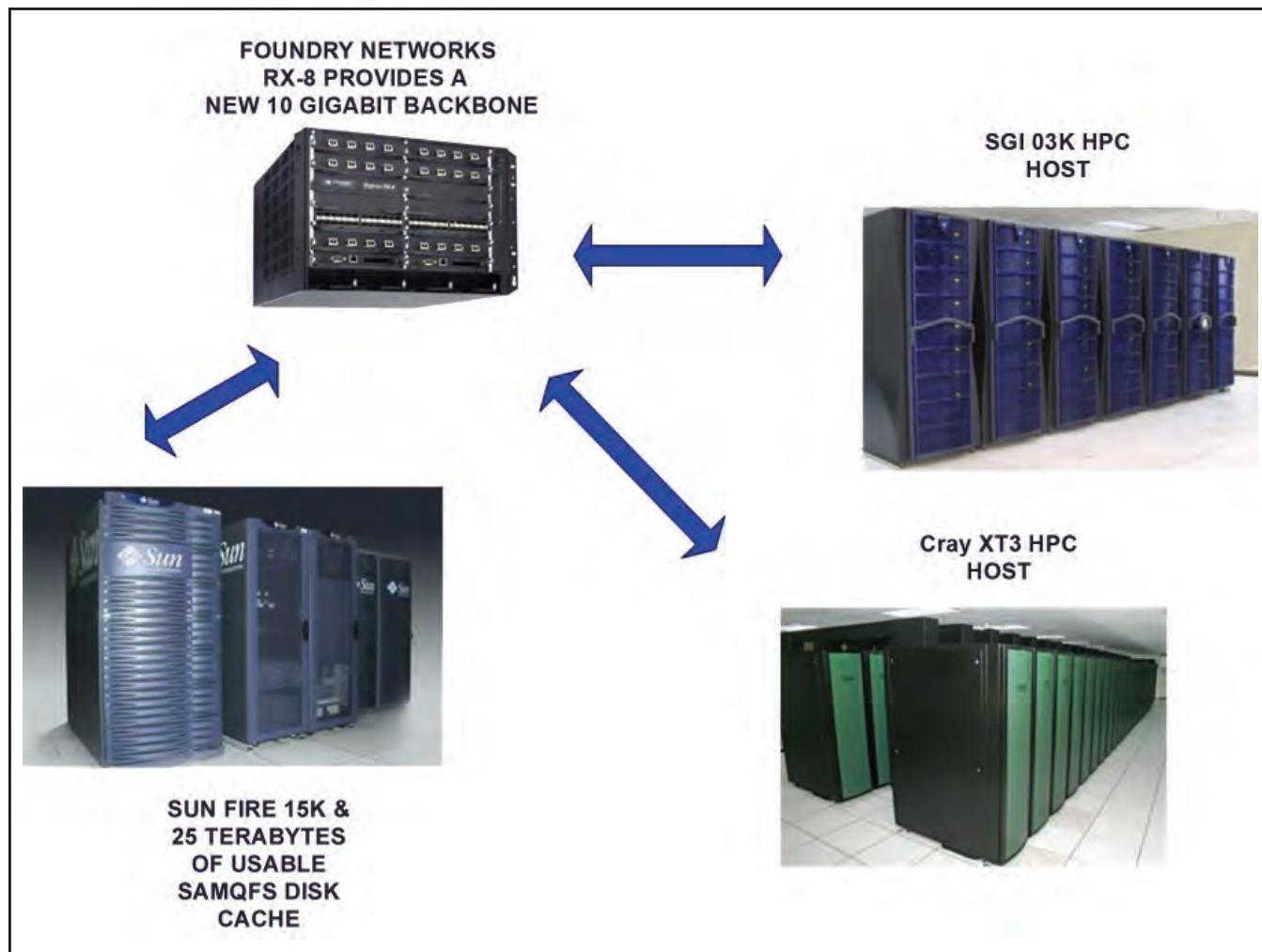
# Improving User Experience and Reducing Time to Solution

By Jay Cliburn

The ERDC MSRC has major improvements planned for the network and mass storage infrastructure in the coming months. First, we plan to replace the existing 1-gigabit Ethernet backbone with a 10-gigabit Ethernet backbone, which will dramatically improve data transfer speed between HPC systems and the mass storage Data Management System (DMS). In conjunction with this change, we also plan to increase the size of the Fibre Channel disk cache on the DMS from about 6 terabytes to about 25 terabytes, quadrupling the amount of data the DMS can hold before flushing files to magnetic tape.

The primary goal of these changes is to reduce the time it takes to push or pull data files between HPC systems and the mass storage system. Our continuing overarching motivation is to improve overall user experience and to reduce time to solution. These infrastructure upgrades take significant strides in that direction.

If you have questions or need additional information, contact the HPC Service Center at [msrchip@erdc.hpc.mil](mailto:msrchip@erdc.hpc.mil).



# A Purpose Driven ... Web Site?

By Glen Browning, ERDC MSRC

In January of 2004, in response to feedback from many of our users, we at the ERDC MSRC undertook a bold initiative to improve the way we communicate with our users. We began with five RSS newsfeeds, a couple of tin cans, and a whisper, "Psst! We've got a better way to communicate."

Two and a half years later, this simple idea has grown into a contagious philosophy that continues to spread within our organization, affecting virtually every activity of User Services. Perhaps nowhere is this change more clearly seen than in our new Web site — [www.erdc.hpc.mil](http://www.erdc.hpc.mil). As you might expect, the cumbersome frames and the tired mid-'90s design have been replaced with a unified page layout and a fresh new look, but the most important change... the change that makes all the difference... is not a change of design, but a change of purpose.

This is more than a clever attempt to sound trendy. In the past the purpose of our Web site was vague and constantly changing, making meaningful content an elusive target. To solve this problem, we decided early in the redesign process to focus on a single, well-defined purpose — **to be useful to our users**. Then we did something truly outrageous. We picked up the phone and started calling them. Who better to tell us what users need? We asked them what they wanted from our Web site. What could we do that would make their lives easier? What would be useful? And then we listened, and the response was eye-opening.

**"... the most important change...  
is not a change of design,  
but a change of purpose."**

We learned that many of our users were new to high performance computing and had never worked in a UNIX environment before. For many of these users, discussions about Kerberized systems and queue priorities seemed like a foreign language. Faced with a mountain of new concepts and terminology they just needed more help getting started, and many didn't know where to turn. A lot of users found the old site confusing and often got lost trying to find information. We also learned that the stiff, formal language of the site was daunting to many and that the content was often too dated to be useful. And finally, we learned



*Postcards sent to every ERDC MSRC user announced the debut of our RSS newsfeeds*

that many people just wanted to know if a system was up or down. With these things in mind, we began laying out the blueprint for a site that would truly meet these needs and many more.

Our first step was to eliminate everything that wasn't inherently useful. In some cases this meant getting rid of content altogether. In others, it meant rewriting documents from scratch or merging multiple, incomplete documents to create a single useful page. Throughout this process nothing was sacred, and whole sections of the original Web site were retired simply because they weren't useful. The result was a much leaner body of content with far fewer pages and useful information on virtually every page.

But, we didn't stop at the level of sections and pages. In many documents, the wording of every sentence was scrutinized. The formal, third person style of writing was replaced with simpler more conversational language. We kept formality to a minimum, and clarity and brevity became the rule of thumb. We made it our goal to never use 20 words to say what could be said more clearly in 10.

We then turned our attention to the structure of the site. After all, it doesn't matter how useful and clear information is if people can't find it when they need it. Starting from scratch, we built a new site structure around the information that users most frequently needed ... system news, documentation, hardware and software details, services, and local information. We made every effort to create an intuitive structure in which information could be easily located. In addition to traditional navigation menus, we added shortcut

questions linking directly to important information deeper in the site. To the System News section, we added a system status summary page with status icons color-coded in the familiar traffic light motif. Green is up. Yellow means possible problems. Red is down. It's that simple. To complete the package, we added a search engine so users could find what they needed as quickly as possible.



*Color-coded icons identify system status*

A detailed set of pages was put in place to answer the top four most frequently asked questions, and the remaining FAQs were divided into Beginner and Advanced documents so that the questions could be addressed in greater detail. The Quick Start Guides and User Guides were enhanced with more thorough explanations, and clearer, more complete examples were added. Information about queue limits and system utilities were reformatted into easy-to-read tables, and Tips & Tricks documents were updated and grouped together by the systems to which they applied. Of course, we knew that we would never be able to anticipate every user's question, but it wouldn't be for lack of trying.

With this exhaustive (and exhausting) array of enhancements in place, we felt that we finally had a site that would serve our users well. Great effort had gone

Next, we shifted focus to the needs of new and prospective users, many of whom are not only new to our Center but to high performance computing as well. For those wanting to become users, we added step-by-step instructions to walk them through the complicated process of getting an account. Following this, we created a guide for new users to take them through their first logon session and answer common questions about Kerberos authentication, job submission and queues, issues unfamiliar to users who have worked mostly with PCs.

**“... it doesn’t matter how useful and clear information is if people can’t find it...”**

into ensuring that every known issue was addressed, and that we had a framework in place that would allow the site to continue to meet the needs of our users in the future. So on January 3, 2006, we launched the new ERDC MSRC Web site and waited to see how our users would respond. And the response was... well, see for yourself. These are just a few of the comments we received.

**“... very, very good. To be able to click about three buttons and see the timely accurate, and complete status of each system, complete with explanations, estimated uptimes, and color-coded pictures, is worth a great deal.”**

**“...well thought out and impressive...”**

**“... an excellent setup.”**

**“I love the new site. It’s ARTISTICALLY pleasing. You did a fabulous job with the new design. What an inspiration...”**

**“Awesome!!”**

The enthusiastic response of our users was quite frankly more than we ever expected, and it confirmed for us that we were indeed on the right track; but it also reminded us of how much more could be done. So after a brief celebration (and some much needed sleep) we found ourselves asking a familiar question, “How can we make this better? Where do we go from here?” Of course, we have lots of ideas, but the answer will be determined by the needs of our users. So, if you have a suggestion...

## **we want to hear from you!**

Call us at **1-800-500-4722**, or send e-mail to [mwebmaster@erdc.hpc.mil](mailto:mwebmaster@erdc.hpc.mil). Our purpose is to be useful to YOU, so tell us your needs and see what happens.

Here we go again! I think I may just put a cot in my office!

# [www.erdc.hpc.mil](http://www.erdc.hpc.mil)

The screenshot shows the ERDC MSRC website. At the top, there's a navigation bar with links for System News, Documentation, Hardware & Software, Customer Service, and About Us. Below the navigation is a sidebar with links for Who We Are, Contact Us, Planning A Visit, The Resource (which is highlighted in red), and Related Links. The main content area features a heading 'The Resource' and a sub-headline: 'Want to learn more about what we do? Take a look at the following issues of our biannual newsletter, the Resource:'. It then displays four issues of the newsletter: Spring 2006, Fall 2005, Spring 2005, and Fall 2004. Below these, there's a link to 'Past issues'.

*Looking for past issues of the Resource? They're all available online at  
[http://www.erdc.hpc.mil/aboutUs/The\\_Resource/home](http://www.erdc.hpc.mil/aboutUs/The_Resource/home)*

# New ERDC MSRC Acting Director

by Rose J. Dykes

Greg K. Rottman was named the ERDC MSRC Acting Director on September 3 when John E. West became the ERDC ITL Acting Deputy Director for the remainder of 2006. Just previous to this appointment, he was serving as an ERDC MSRC Assistant Director with responsibility for all business aspects of the Center. In 2005 he received the HPCMP Hero Award for the category *Innovative Management* for demonstrating creative business practices to improve overall HPCMP business model.

The first DoD HPCMP Metacomputing Grid Workshop was hosted by the ERDC MSRC in early 2002. Attendees from across the Nation attended this 4-day event for which Greg served as workshop coordinator. Greg had served as the HPCMP Project Manager for the metacomputing initiative, developing proposals, schedules, and budgets for research work to be done. His responsibility included coordination of project activities with a geographically dispersed team and performing liaison functions with working groups dedicated to metacomputing technologies.

In 2001, Greg completed the Army's 3-year premier leadership development program for engineers and scientists—one of only two people from ERDC with this accomplishment. He was also serving as the Government lead for HPC systems operation at the ERDC MSRC at this time.

Greg came back to ERDC in 2000 as a civil engineer working for the ERDC MSRC. Just previous to joining the ERDC MSRC, Greg spent 5 years in the Programs and Project Management Division at the U.S. Army Engineer District, Vicksburg. He had returned to Government service at the ERDC ITL, where he worked in Customer Assistance and served as project engineer and project manager for the Electronic Information Exchange Project, before the Vicksburg District assignment.

In 1984 Greg went to work for Tektronix, Inc., as a system analyst, advancing through the ranks of senior



Multitasking, fun-loving Greg (far right) was a quartet member of the "ERDC MSRC Singing TERROR flops" at the MSRC "We Are Watching You" surprise celebration in honor of John West. Also pictured (left to right) David Stinson on keyboard; John Mason, guitar; Trent Townsend, guitar; and other quartet members "Tiny" Tim Dunaway, Dr. Jeff Hensley, and Mickey Robertson

systems analyst, product support analyst, national sales training manager, and sales engineer. Previous to this he had worked as a hydraulic engineer for the U.S. Army Corps of Engineers in Fort Worth, Texas, after earning his B.S. degree from Texas Tech University in 1977.

In addition to being honored with three Commander's Awards during the last few years, Greg has also served as a member of the Diocese of Jackson School Board, Jackson, Mississippi, and member of the Development Committee at the Vicksburg Catholic Schools, Vicksburg, Mississippi. Under his leadership as the Grand Knight, the Vicksburg Knights of Columbus received the highest award in the State of Mississippi for the 2 years Greg served.

The ERDC MSRC feels fortunate to have Greg as a member of its team and to have him serve as its Acting Director while John West is serving in another capacity.

# About PET

By Dr. Jim Pennington

The User Productivity Enhancement and Technology Transfer (PET) program is responsible for gathering and deploying the best ideas, algorithms, and software tools emerging from the national high performance computing infrastructure into the DoD user community. PET, in its sixth year under the current contract with DoD's High Performance Computing Modernization Program (HPCMP), is supported by two contracts: the first with the MOS consortium led by Mississippi State University and the Ohio Supercomputer Center; the second with High Performance Computing Technologies Inc. (HPTi). MOS is responsible for PET Components 2 and 3, which are hosted by the Major Shared Resource Centers (MSRCs) at the Aeronautical Systems Center (ASC), Wright-Patterson Air Force Base, at Dayton, Ohio, and the U.S. Army Engineer Research and Development Center (ERDC) at Vicksburg, Mississippi, respectively. HPTi is responsible for PET Component 4, which is hosted at the Army Research Laboratory at Aberdeen Proving Ground, Maryland. The functions and responsibilities of PET Component 1, which had been hosted by the Naval Oceanographic Office (NAVO) at Stennis Space Center, Mississippi, were transferred into Components 2 and 3 in June 2006.

The PET team consists of university and industry partners that are located from Hawaii to the East Coast. PET brings the expertise of these institutions to bear in support of DoD HPC users through technology transfer, training, and collaborative assistance in several computational technology areas (CTAs). Functional area points-of-contact (FAPOCs) are provided for each of the CTAs and crosscutting support areas. The FAPOCs field a team of onsite staff located at the DoD centers with HPC user concentrations and are supported by other staff at the PET team home institutions. The PET onsite staff supports DoD users across the HPCMP and not just the users at their respective locations. PET onsite resources at the ERDC MSRC are Dr. Nathan Prewitt for Computational Fluid Dynamics (CFD), Dr. Rick Weed for Computational Structural Mechanics (CSM), and Dr. Jeff Hensley for Environmental Quality Modeling and Simulation (EQM). Drs. Prewitt, Weed, and Hensley are available to assist all HPC users in DoD just as assistance is available to ERDC users in other CTAs from PET university faculty and onsite leads at other MSRCs and DoD facilities.

The CTAs are operated by assigning the technical areas to one of the three components with each component managed by a Component Point-of-Contact (CPOC). Component 3 is managed by Dr. Jim Pennington, the CPOC. Government oversight for this component is provided by Mr Chris Merrill, ERDC/ITL, who serves the HPCMP Office as the PET Component 3 Technical Assistant (see insert on page 29). PET Component 3 is responsible for collaborative user support in four CTAs: CFD, CSM, EQM, and Climate/Weather/Ocean Modeling and Simulation (CWO). Component 3 is also responsible for one of the crosscutting functional areas, Education, Outreach, and Training Coordination (EOTC).

## PET Summer Interns

One of the methods to influence growth of the DoD-specific workforce is through the PET Summer Intern program, which is coordinated by the EOTC crosscutting functional area. The intern program funds students to work and learn at a DoD HPC Center in collaboration with a PET mentor. The students see firsthand what opportunities exist in the DoD centers and how exciting the world of HPC can be. The hope is that some of them will seriously consider a career at a DoD site.

The Summer Intern program is open to all undergraduate and graduate students with U.S. citizenship. Student recruitment begins in the winter by personal contact with university deans, department heads, senior faculty and other points-of-contact. A mentor will direct the student's summer activities with the PET program. The mentor will be skilled in a relevant technical area and will possess the needed skills in interpersonal relationships to articulate appropriate statements of work and devise individual development plans that are consistent with the student's interests and capabilities. The mentor will direct the student's day-to-day activities during the summer and will be responsible for assigning the student meaningful projects that are not only of value to the DoD but also contribute to the student's knowledge and maturity in the field of HPC.

In 2006, PET sponsored 43 summer interns, 8 of whom spent their summer at the ERDC MSRC.



**Corey Bordelon** worked under the mentorship of John Mason in ERDC's Major Shared Resource Center on creating a new system to assist in the retrieval of documents on the Online Knowledge Center site. Corey graduated from the

University of Louisiana at Monroe in May with a degree in computer science. The Marksville, Louisiana, native is attending the University of Louisiana at Lafayette for his master's in computer science.

The screenshot shows the HPC website with the 'CFD' section highlighted. The 'CFD Mission' section describes the accurate numerical solution of the equations describing fluid and gas motion. The 'CFD Strategic Objectives' section lists goals such as verification and validation of codes, rapid and robust time-accurate solvers, dynamic and adaptive meshing, and incorporation of CFD tools. A 3D visualization of a jet engine's flow field is shown on the right.



**Naomi Brown** worked under the mentorship of Drs. Alvaro Fernandez and Paul Bennett in ERDC's Major Shared Resource Center. While working with Fernandez, she learned about meshless methods for solving model convection-diffusion problems and helped extend his current algorithm

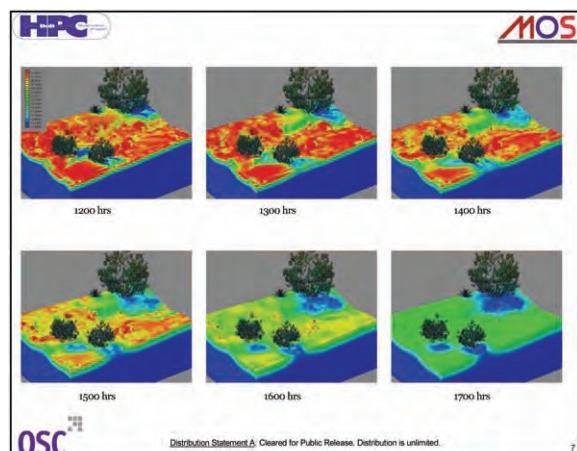
to two-dimensional problems. Naomi's work with Bennett pertained to laser propagation through nonlinear materials. She performed a series of tests to determine where the code needs to be more robust. Naomi is in her third year at the University of Hawaii at Manoa and is pursuing a bachelor's in physics.

The diagram is titled 'The Process' and illustrates the finite element method. On the left, a 3D plot shows a complex domain with a mesh and the text 'Trial functions'. An arrow points to a 2D plot on the right, which shows a single triangular element with axes labeled 'x' and 'y'.



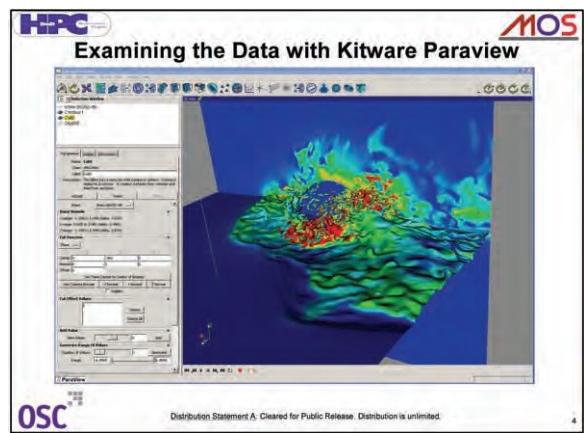
**Ihsan Hakima** worked in ITL's Engineering and Information Systems Division, under the mentorship of Dr. Owen Eslinger. They were developing iterative methods of finding the thermal diffusivity from the heat equation by the finite difference method and

comparing the results to field data. Ihsan is an electrical engineering and mechanical engineering major at the University of Alabama at Birmingham.

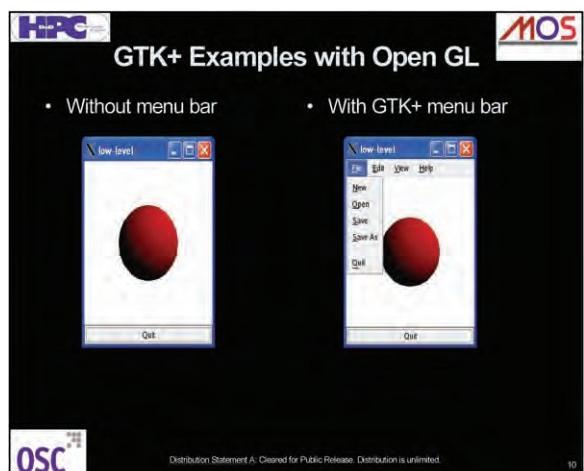




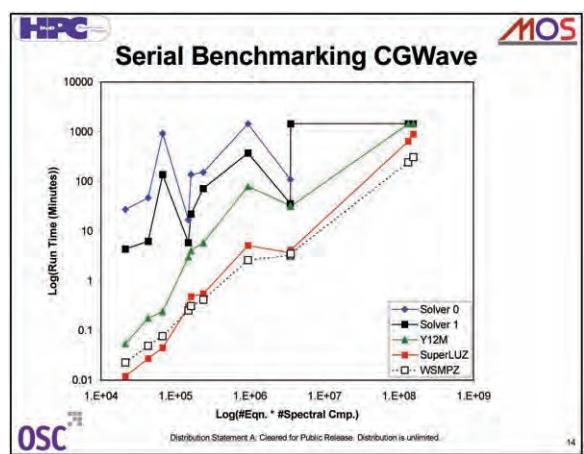
**Caitlin Wolfe** worked under the mentorship of Paul Adams in the ERDC Major Shared Resource Center's Scientific Visualization Center on a project involving movement in water to create animation. The Brandon, Mississippi, native is majoring in aerospace engineering at Mississippi State University.



**Maryum Haston** worked under the mentorship of Dr. Nathan Prewitt in ERDC's Major Shared Resource Center, trying to convert a visualization code to run under Linux and Windows using GTK+, a multiplatform toolkit for creating graphical user interfaces (GUI), and libglade to produce a new GUI for the code. The Mobile, Alabama, native is seeking a degree in mechanical engineering at the University of Alabama at Birmingham.



**Steven A.E. Miller** is working on his doctorate in aerospace engineering in computational fluid dynamics and computational aeroacoustics at The Pennsylvania State University. His mentors were Dr. Thomas C. Oppe, ERDC Major Shared Resource Center and Dr. Zeki Demirbilek, CHL. Steve, a native of Saline, Michigan, is working on direct and iterative sparse matrix solvers for CGWave and updating CGWave on various computer platforms.





**Kendria Favors** worked with Renee Mullinax, Engineering and Informatic Systems Division. The Atlanta, Georgia, native worked on implementing enhancements to the PET Online Knowledge Center using JSP communicating with an Oracle Database.

Kendria attends Albany State University and is majoring in mathematics and industrial engineering as part of a dual degree program with the Georgia Institute of Technology.

The screenshot shows a Microsoft Internet Explorer window titled "Automatic Report Generator - Microsoft Internet Explorer". The URL is https://134.164.184.32:8443/rkc/wepespj/report/quarterlyReport.jsp? The page displays a form with dropdown menus for "Course Type" (Regular In-Class), "Quarter" (1st Quarter: June, July, Aug.), "Year" (2002 (Y/Q)), "Report Type" (Total Number of Courses), and "Sorted by" (Functional Area). A "Submit" button is at the bottom. The MOS logo is in the top right corner.



**Lan Holloway**, Clinton, Mississippi, worked under the mentorship of Dr. Sam Cable, ERDC Major Shared Resource Center. They looked at the bow shock surrounding the earth and magnetosphere and how the density, velocity, and pressure of the wind vary in this region. Lan is a sophomore at

Mississippi State University and is majoring in mechanical engineering. He is pursuing minors in mathematics and computer science.

The screenshot shows a page titled "Data Examples" from the HPC system. It features four subplots arranged in a 2x2 grid, each showing a semi-circular arc with a color gradient. The top-left plot is labeled "Magnetic Field", the top-right is "Density", the bottom-left is "Pressure", and the bottom-right is "Velocity". The background of the page has the HPC and MOS logos. At the bottom, it says "OSC" and "Distribution Statement A: Cleared for Public Release. Distribution is unlimited."

(Text and photographs of Summer Interns courtesy of Marsha Gay)



**Mr. Chris Merrill** is the new PET Component 3 Technical Assistant. This component, hosted by the ERDC MSRC, includes the computational technical areas (CTAs) of Computational Fluid Dynamics (CFD), Computational Structural Mechanics (CSM), and the newly added CTAs of Environmental Quality Modeling and Simulation (EQM), and Climate/Weather/Ocean Modeling and Simulation (CWO). Component 3 is also responsible for the crosscutting functional area of Education, Outreach, and Training Coordination (EOTC).

Mr. Merrill began his career in 1977 as an employee of the U.S. Army Engineer District, Tulsa. In 1979 he transferred to a structural engineering position with the

U.S. Army Engineer District, Kansas, where he worked in the Reservoir Structures Section. In 1984 he transferred to the U.S. Army Engineer Waterways Experiment Station, now the Engineer Research and Development Center, where he worked on the computer-aided structural engineering project, guidance update programs, and performed complex analyses for various Corps offices. He became Chief of the Computational Science and Engineering Branch (CSEB) of the ERDC Information Technology Laboratory in 2002. The CSEB consists of 20 engineers and scientists with an annual budget exceeding \$3.5M.

Mr. Merrill earned his B.S. degree in civil engineering from Oklahoma State University and received his M.S. degree in civil engineering from Mississippi State University. He is a member of the American Society of Civil Engineers.

# Ready To Change The World?

By Trent Townsend

Fresh out of college, most new graduates are ready to tackle the world with breathtaking, revolutionary ideas. However, seldom does this phenomenon actually take place. More often than not, new graduates take the customary entry-level position in hopes of moving up the corporate ladder... at which point they can eventually reshape the world in which we live. The mindset of the future working force is not so hard to understand: they have just spent the majority of their lives and countless dollars preparing for this moment. Everyone has always told them college is a necessity to be successful, so why would this dream not crystallize into such alleged success? The problem is that college does not teach us all we need to know but rather prepares us to learn while on the job. We are given the basics and indeed the necessities to be successful, but college cannot nor should it claim to provide the job experience needed to make an impact immediately.

Not being too far removed from this scenario, I am still able to relate. I now know that employers want to see a degree to prove that college graduates have the potential to do the job, but it was not always that clear. However, I was extremely fortunate in that I undertook two internships while in college, one of which turned into a more permanent position during my undergraduate education. After the first internship, I completely recognized the value in job experience in addition to a college education. Thus, when I was ready to take the second internship, I knew what to expect and what I would hopefully gain from the experience.

This second opportunity to gain invaluable experience came when I worked two summers as a security intern here at the ERDC MSRC. Coming from a programming background and stepping into a new field in information assurance, I was what could be described as "green." I knew of a few basic ideas and principles that information assurance encompassed but was not ready to take full hold of a permanent position in this field. However, the difference was that I knew this and prepared myself to learn rather than to immediately make an impact on programwide levels.

Being fortunate to be placed under knowledgeable and experienced mentors who took time out of their schedule to answer my endless questions, I indeed gained the experience I needed. I learned much about the daily activities I could expect once I took a full-time position and how to be of more impact when that time arrived. But more than that, I was able to learn about such



Trent Townsend (left), ERDC MSRC, and Nathan Necaise, ERDC MSRC Summer Intern

things while doing work that actually needed to be done rather than just doing "busy work" the entire summer. This is where the real motivation for learning is inspired. Knowing what you are doing is going to make a difference in at least a small degree and will not be tossed aside when you are gone makes a difference in the attitude used while approaching a task.

After having such good experiences as an intern, I took the new opportunity presented to me when our recent security intern, Nathan Necaise, arrived and tried to provide the same leadership to him. I tried to make his transition into our ranks easier by his work assignments clear and meaningful, and tried to provide the needed guidance to accomplish those tasks. These were all benefits I received. Not surprisingly, I found Nathan was similar to me when I first came here. He was somewhat inexperienced in the reality of what information assurance professionals encounter on a day-to-day basis. To Nathan's credit, he is a very quick learner and works very hard to provide genuine results that can be of immediate help. With such qualities, it was not hard for him to learn new ways to accomplish tasks, realize why we do things in certain ways, and manifest these lessons in the form of several useful projects. Keeping in mind that he needed to be challenged in ways that he could learn while providing benefits to the Center, the security team collectively came up with a set of items to which we wanted Nathan to be exposed in some way. This took shape in several exercises involving the Perl scripting language, practical research involving Kerberos and CAC applications on Mac OS X, and a research paper to name a few. For every task given to



Nathan Necaise (third from left) with ERDC MSRC Security Team members (left to right) George Moncrief, Trent Townsend, and Charles Ray

him, Nathan quickly produced results and even took the initiative to go beyond what we requested and do research on his own. As the summer came to an end, he expressed to me that he had enjoyed his time here but more importantly felt his benefit from the experience had been great. Certainly, the gain was mutual for the MSRC.

To be stated clearly and reiterated, I cannot emphasize the importance of these internships enough. They are beneficial for the MSRC in that we get the fruits of interns' time here, but we also get the privilege of

providing the experience and preparation needed for future careers to each of these interns. As a research and development center for the Army, these achievements should remain high on our list of objectives. Not only does it make the ERDC MSRC better, it makes a difference to interns who receive positive reinforcement and much needed job experience. If you have such an opportunity to mentor an intern in a similar situation, keep in mind the privilege you have just been given. They still may change the world.

## SAME U.S. Army Camp Students Visit ERDC MSRC

by Rose J. Dykes

The ERDC MSRC participated in the annual Society of American Military Engineers Engineering and Construction Camp held in Vicksburg on June 11-17, 2006. This 1-week camp provides high school students with hands-on experience in engineering and construction activities and is supervised by professional engineers and volunteers from organizations in the lower Mississippi Valley. Crewmates (campers) are exposed to knowledge about various choices in the fields of engineering and construction primarily on water resources.



Dr. William Ward (far right), ERDC MSRC Computational Science and Engineering Lead talks with a group of campers in the HPC Center

# Users Group Conference 2006

By Rose J. Dykes

The DoD High Performance Computing Modernization Program Users Group Conference held its 16<sup>th</sup> annual meeting in Denver, Colorado, on June 26-29, 2006. Approximately 400 attendees gathered to attend plenary sessions, computational project presentations, a poster session, and social events offering the opportunity for networking, renewing old contacts, and following up on questions not asked during individual computational project talks.

The ERDC MSRC participated by making seven oral presentations and seven poster presentations.

## Oral Presentations:

Randall Hand – “**Visualization of Time-Dependent, Quasi-Streamwise Vortex Tubes in a Bubble-Laden Turbulent Boundary Layer over a Flat Plate**”

Keith Rappold - “**UIT Development: How to Access HPC Resources Using the UIT Web Service**”

Paul Adams – “**Parallel Visualization of Time-Dependent Data Sets on a Tiled Display**”

Tom Biddlecome – “**Volume Rendering on Graphics Processors**”

Dr. Fred Tracy – “**Accuracy and Performance Testing of Three-Dimensional Unsaturated Flow Finite Element Groundwater Programs on the Cray XT3 Using Analytical Solutions**”

Dr. Ruth Cheng – “**Development of a Parallel Coupler for a Watershed Model**”

Dr. Jeff Hensley – “**An Overview of the Capabilities and Performance of I/O on the Cray XT3 Using the Lustre File System**”

## Poster Presentations:

Dr. Paul Bennett – “**Targeting CCM-, CEA-, and CSM-Based Computing to Specific Architectures Based Upon HPCM Systems Assessment**”

Patti Duett – “**ezHPC: Simplifying Access to ERDC MSRC HPC Resources**”

Randall Hand and Paul Adams – “**ezVIZ – An Open-Source, Cross-Platform Visualization Tool**”

Amanda Hines – “**Parallel XMDF: A Portable Parallel I/O Format**”

Keith Rappold – “**ezHPC Security Internals**”

Renee Mullinax, Dean Hampton, Abdul Mohamed, John Mason, and Patti Duett – “**OKC: A Look at the New PET Online Knowledge Center**”

Trent Townsend, George Moncrief, and Scotty Swillie – “**ezHPC Security Architecture**”

*Tuesday night Poster Session—ERDC posters displayed on either side of this walk-through area*





(Left to right) Barbara Rooks-Jackson, Executive Assistant, and Jo Ann Clark, Staff Assistant, both from Office of U.S. Senator Thad Cochran (R-MS); John E. West, ERDC Information Technology Laboratory Acting Deputy Director; and Dr. James Houston, ERDC Director, September 12



(Left to right) Dr. Doug Post, Chief Scientist, DoD High Performance Computing Modernization Program, Arlington, Virginia; Dr. Deborah Dent, Acting Director, ERDC Information Technology Laboratory; and Dr. Robert Maier, Assistant Director, ERDC MSRC, August 28



# visitors

*Paul Adams (right), ERDCMSRC Scientific Visualization Lead, demonstrating a project on RenderWall for Elwyn Darden, Special Assistant to the Assistant Secretary of the Army (Civil Works), Washington, D.C., and Natalie Darden, August 24*



*(Left to right) Paul Adams; Dr. Guillermo Riveros, ERDC ITL; Dr. Domingo Rodriguez, Department of Civil Engineering, and Dr. Ismael Pagan, Department Head, University of Puerto Rico, Mayaguez, August 10*

*LTG Carl A. Strock (far left) walks through Joint Computing Facility as Dr. Jeffery P. Holland (second from right), ERDC Acting Deputy Director, and John West (far right) discuss supercomputing infrastructure, July 18*



*U.S. Representative Bennie Thompson (D-MS) (center), discusses Homeland Security with Dr. Holland (left) and John West (right), July 3 (photograph courtesy of Marsha Gay)*

Below is a list of acronyms commonly used among the DoD HPC community. These acronyms are used throughout the articles in this newsletter.

AFIT	Air Force Institute of Technology	GUI	Graphical User Interface
AMR	Adaptive Mesh Refinement	HPC	High Performance Computing
API	Application Programming Interface	HPC <sup>2</sup>	HPC Collaboratory
ASC	Aeronautical Systems Center	HPCMP	High Performance Computing Modernization Program
CFD	Computational Fluid Dynamics	HPCMPO	HPCMPO Office
CHL	Coastal and Hydraulics Laboratory	ITL	Information Technology Laboratory
CPOC	Component Point-of Contact	MSRC	Major Shared Resource Center
CPU	Central Processing Unit	MSU	Mississippi State University
CSEB	Computational Science and Engineering Branch	NAVO	Naval Oceanographic Office
CSM	Computational Structural Mechanics	NDBC	National Data Buoy Center
CTA	Computational Technology Area	PET	User Productivity Enhancement and Technology Transfer
CWO	Climate/Weather/Ocean Modeling and Simulation	PFLOPS	One Thousand TFLOPS
DAC	Divide and Conquer	R&D	Research and Development
DMS	Data Management System	SAME	Society of American Military Engineers
DoD	Department of Defense	SHAMRC	Second-order Hydrodynamic Automatic Mesh Refinement Code
EOTC	Education, Outreach, and Training Coordination	SOAP	Simple Object Access Protocol (XML protocol)
EQM	Environmental Quality Modeling and Simulation	S&PS	Survivability and Protective Structures
ERDC	Engineer Research and Development Center	TFLOPS	Trillion Floating-Point Operations per Second
FAPOC	Functional Area Point-of-Contact	TMax	Temporal Maxwell solver
FAQs	Frequently Asked Questions	UIT	User Interface Toolkit
FMS	Forces Modeling and Simulation	USAF	United States Air Force
GBytes	Gigabytes	WIS	Wave Information Study
GSL	Geotechnical and Structures Laboratory		

# training schedule

For the latest on training and on-line registration, one can go to the User Productivity Enhancement and Technology Transfer (PET) Online Knowledge Center Web site:

<https://okc.erdc.hpc.mil>

Questions and comments may be directed to PET at (601) 634-3131, (601) 634-4024, or [PET-Training@erdc.usace.army.mil](mailto:PET-Training@erdc.usace.army.mil)



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Telephone: 1-800-500-4722

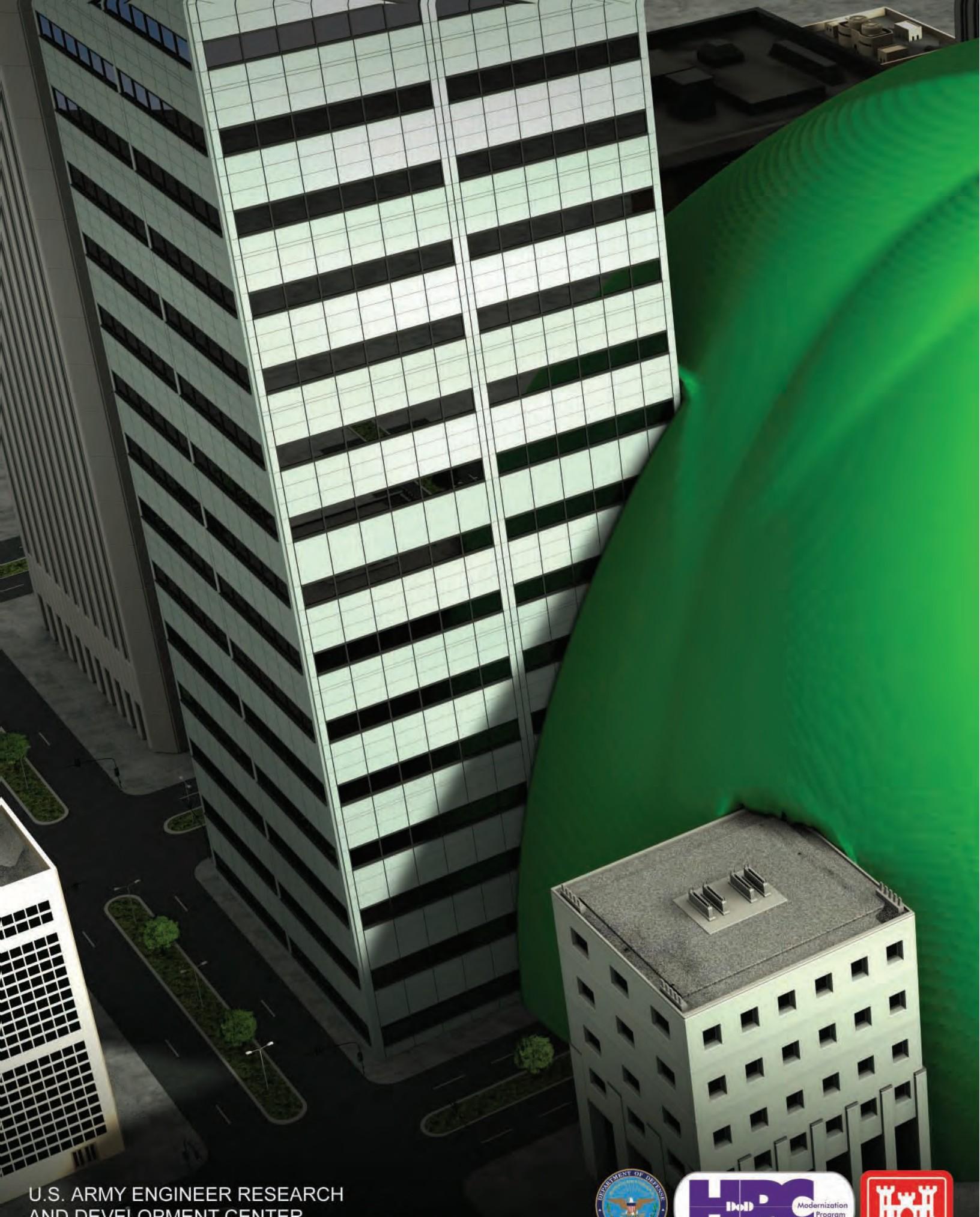
The ERDC MSRC welcomes comments and suggestions regarding the *Resource* and invites article submissions.  
Please send submissions to the above e-mail address.

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Design and layout provided by the Visual Production Center, Information Technology Laboratory, U.S. Army Engineer Research and Development Center.

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